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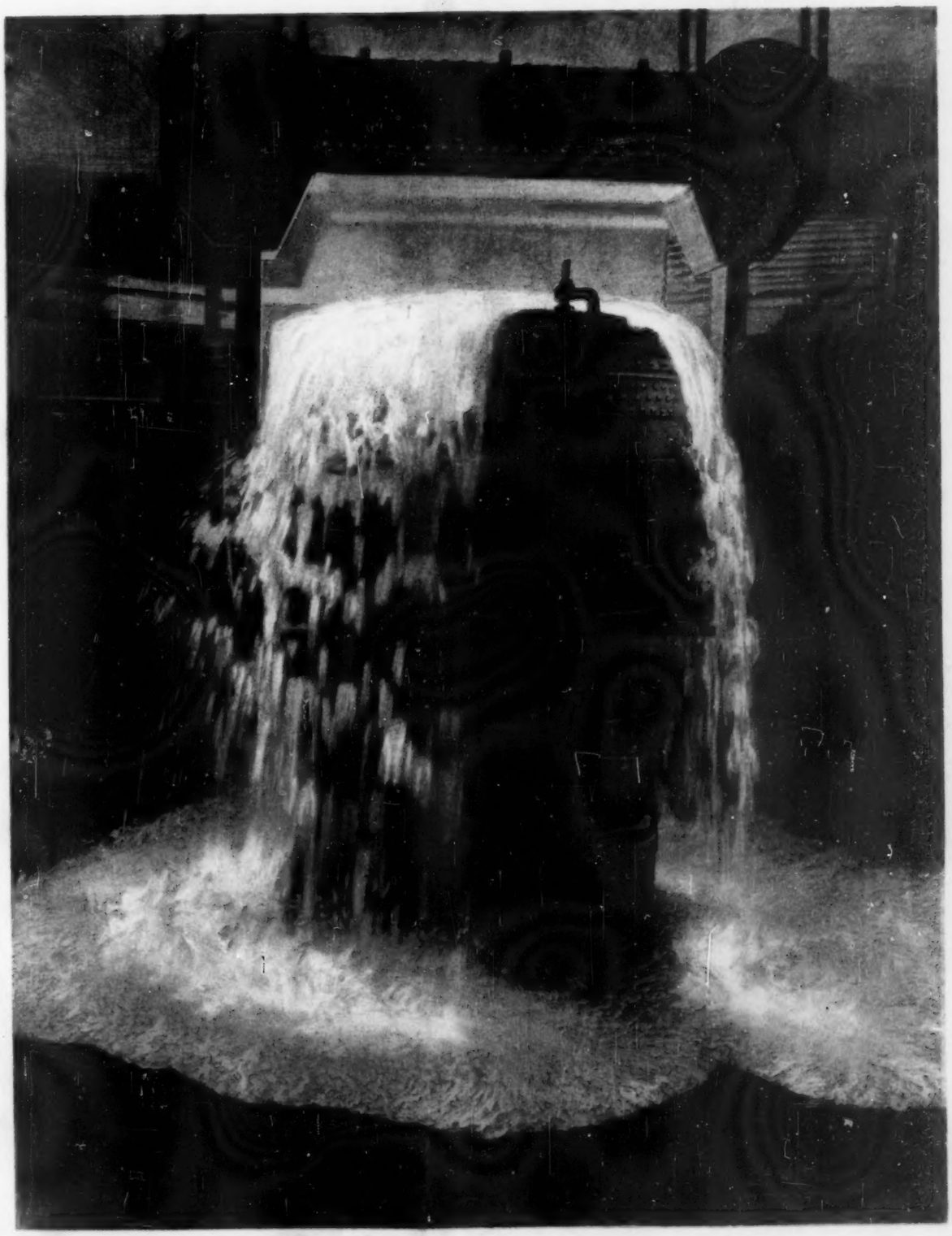

FILLING A 100-TON LADLE WITH WHITE-HOT MOLTEN STEEL—[See page 57]

Vol. CXXI. No. 3
July 19, 1919

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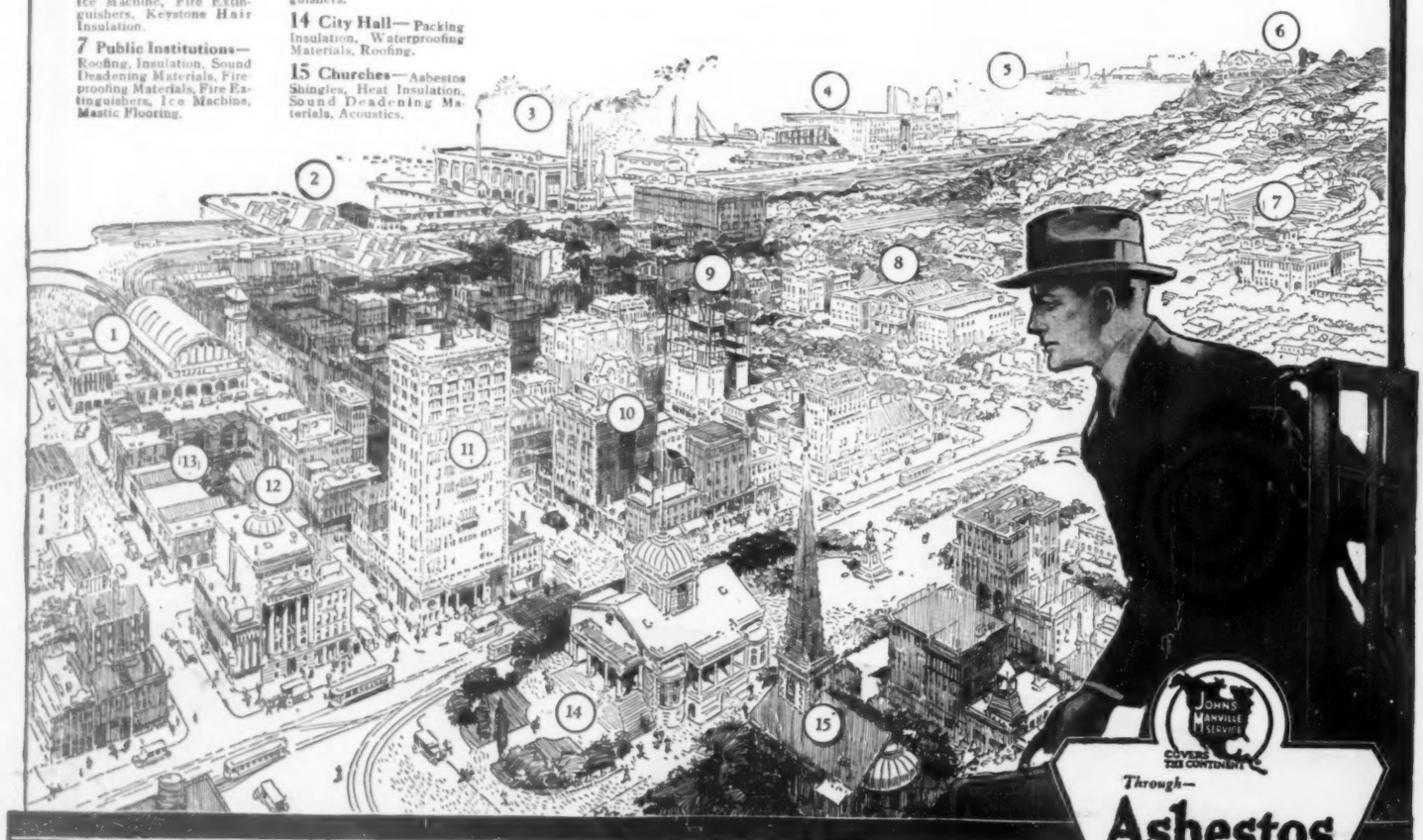

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SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXI.
NUMBER 3

NEW YORK, JULY 19, 1919

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Effect of the War on the World's Shipping

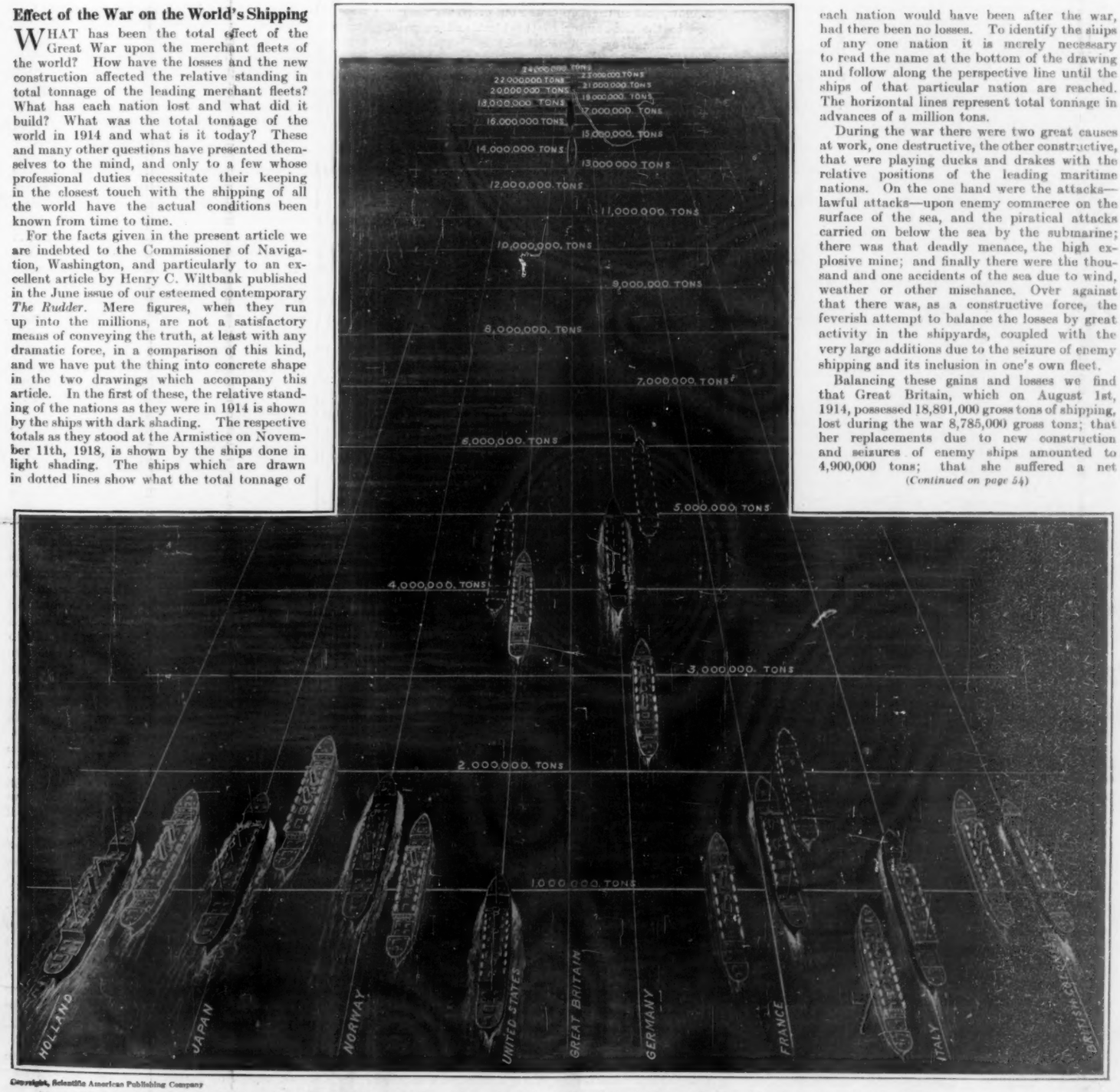
WHAT has been the total effect of the Great War upon the merchant fleets of the world? How have the losses and the new construction affected the relative standing in total tonnage of the leading merchant fleets? What has each nation lost and what did it build? What was the total tonnage of the world in 1914 and what is it today? These and many other questions have presented themselves to the mind, and only to a few whose professional duties necessitate their keeping in the closest touch with the shipping of all the world have the actual conditions been known from time to time.

For the facts given in the present article we are indebted to the Commissioner of Navigation, Washington, and particularly to an excellent article by Henry C. Wiltbank published in the June issue of our esteemed contemporary *The Rudder*. Mere figures, when they run up into the millions, are not a satisfactory means of conveying the truth, at least with any dramatic force, in a comparison of this kind, and we have put the thing into concrete shape in the two drawings which accompany this article. In the first of these, the relative standing of the nations as they were in 1914 is shown by the ships with dark shading. The respective totals as they stood at the Armistice on November 11th, 1918, is shown by the ships done in light shading. The ships which are drawn in dotted lines show what the total tonnage of each nation would have been after the war, had there been no losses. To identify the ships of any one nation it is merely necessary to read the name at the bottom of the drawing and follow along the perspective line until the ships of that particular nation are reached. The horizontal lines represent total tonnage in advances of a million tons.

During the war there were two great causes at work, one destructive, the other constructive, that were playing ducks and drakes with the relative positions of the leading maritime nations. On the one hand were the attacks—lawful attacks—upon enemy commerce on the surface of the sea, and the piratical attacks carried on below the sea by the submarine; there was that deadly menace, the high explosive mine; and finally there were the thousand and one accidents of the sea due to wind, weather or other mischance. Over against that there was, as a constructive force, the feverish attempt to balance the losses by great activity in the shipyards, coupled with the very large additions due to the seizure of enemy shipping and its inclusion in one's own fleet.

Balancing these gains and losses we find that Great Britain, which on August 1st, 1914, possessed 18,891,000 gross tons of shipping, lost during the war 8,785,000 gross tons; that her replacements due to new construction and seizures of enemy ships amounted to 4,900,000 tons; that she suffered a net

(Continued on page 54)



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Ships with dark shading show relative position of fleets August 4, 1914. Those with light shading show relative position November 11, 1918. The ships drawn in dotted lines show how fleets would have stood had there been no war losses and new construction had proceeded at normal rate

Effect of the war on the relative standing of the world's merchant fleets

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The Airship of the Near Future

THOSE of us who saw the great airship, R-34, land her crew of 30 officers and men at Roosevelt Field, Long Island, after fighting her way for over four days against the westerly winds of the Atlantic, realized that something epochal had happened in the history of the world's progress.

And yet, scarcely had that stupendous and altogether beautiful ship of the air landed her officers and crew upon American soil than General E. M. Maitland, who was chiefly responsible for the great development of British aviation during the war, said of R-34: "That ship is not big enough for the trip, and we had anxious times owing to our supply of petrol running low. With ships five times larger than our own you will have no trouble." He predicted that the ships of the future would have a speed of 100 miles an hour and a lifting effect of 200 tons, with ample capacity to carry passengers, mail and the necessary fuel. This statement was made at a luncheon given by the Navy Department at Garden City, at which Vice-Admiral Gleaves, on behalf of Secretary Daniels, welcomed the officers of R-34 a few hours after their arrival.

We are told that the British have now under way the construction of an airship of about twice the size of R-34 and General Chas. T. Menoher, Director of United States Army Aviation, concurred in the belief that it would be a matter of few years before we should have ships five times larger than that which had just arrived. He stated that such a ship with a capacity of 200 tons dead weight would be capable of carrying a battalion, armed and equipped.

Nor would the construction of an airship five times larger than R-34 call for such a great increase in linear dimensions as might be supposed. The relative lifting capacity of airships increases approximately as the cube of their respective lengths, and a ship about 1150 feet in length and of proportionate diameter would have five times the lifting capacity of R-34, which is 670 feet in length. A ship of such dimensions should be capable of making from 90 to 100 miles per hour, and it would have sufficient power to maintain a high average speed with an ample reserve of fuel, under the conditions of prevailing head winds which had just about emptied the fuel tanks of R-34 as she made her last spurt for the Mineola landing.

Anyone who saw the way in which the big airship swung to and fro the hundreds of men that were holding her down at Mineola when the wind velocity was not over 20 miles an hour, will understand what a great risk was taken at the present stage of the art, in landing so big a ship on American soil, in the open. It is deemed expedient to house these ships in sheds whose dimensions are already enormous and whose cost is very great. We are fully convinced that sheds will come to be regarded as drydocks for repair work only, especially when airships grow to the size predicted by General Maitland.

Long before the war, at the time when Zeppelin was losing so many of his ships through disasters in landing, the SCIENTIFIC AMERICAN indicated that there was only one safe and logical way to handle big airships when they came into port. We pointed out that the ship of the air when it approaches the earth, is very much in the position of the ship of the seas, inasmuch as it is exposed to its greatest danger, not from its native element, but from the land and the reefs and rocks of the coast line. We advocated at that time a policy of anchoring the ship, nose on, to a lofty mooring tower, about which she could swing head to the wind in whatever direction it might blow, just as the ship of the sea drops her anchor head on to the tideway, or to the blast and surge of wind and sea in an exposed roadstead.

That this is a fundamental necessity is now coming to be recognized, and when the passenger airship of the future noses up to the top of a mooring mast and is made fast, her captain will be relieved of the harassing anxieties which have attended the stay of R-34 in our midst.

The value of this great accomplishment and that when the NC-4 made her memorable trip, is not less moral than material; and the American people, no doubt, will endorse the sentiments of Vice-Admiral Gleaves in his speech of welcome: "There is a deeper significance; it is that your airship has spun a cable across the Atlantic which binds still closer the great nations of the world. In the last four years, Great Britain and America have been brought into close contact by blood and iron—a union never to be severed except by the disruption of the whole civilized world. It is the duty of every American and British officer in season and out to preach that doctrine. It is a gracious act upon the part of the British Admiralty to invite an American officer to cross on the ship. It was unselfish, and none will fail to appreciate that demonstration of good feeling."

The Industrial Democracy

THE United States is a democracy. Every citizen has his voice in the conduct of affairs. He may be overruled by the majority, but he has at least had his voice, and if he can get a majority to think as he thinks, he can get done what he wants done; always his opinion goes for what it is worth in the formulation of policy.

In the average industrial organization, there is little of this spirit. Motion is from the top downward. If the fellow at the bottom doesn't like the things that happen, he has one remedy—get out. Nor does it often occur to those at the top, who form decisions, that this is a bit unfair, a bit like asking a lifelong American to get out because he doesn't care for prohibition or Sunday baseball or the complexion of Congress.

The old time autocracy was opposed, bitterly opposed, to the coming of political democracy—because it promised to interfere with the autocratic enjoyment of power. In the same way, present day industrial and commercial autocrats often object to any suggestion for giving the employees a little voice in the running of the plant—because this would interfere with the autocratic enjoyment of power. But if political autocracy is not to be, there seems no very rational ground for tolerating any other kind of autocracy. Why should not every man have his voice in the things that concern him as a buyer and a seller of goods and of labor, as well as in those that concern him as a citizen?

There is today a growing conviction that this suggestion should be carried out—even that it must be carried out. More and more we read of schemes looking toward the participation of the workers in the control and in the profits of the plant. More and more we are getting away from the theory that the plant should be run in the exclusive interests of the proprietors, just as a hundred years ago we were getting away from the idea that the government should be run in the exclusive interests of the few who till then had been its proprietors.

A typical industrial democracy is that of a large tobacco pipe factory in New York city. The model here is the Federal Constitution, with a Cabinet composed of the company executives, a Senate composed of the foremen and heads of departments, and a House of Representatives elected by the whole body of workers. Meetings are held weekly, and such questions as wages, hours of work, holidays, labor turnover, quality and quantity of work, sanitation and similar subjects are thoroughly discussed by the legislative bodies, meeting on the company's time. The plan provides for a dividend system, whereby the company and the employees share, half and half, any saving in production cost, whether gained through increased output or through saving in overhead.

It is found that, just as it pays to give the men a square deal in tangible items like pay, hours, comfortable working stations, etc., it also pays to give them a square deal in the less tangible element of plant government. That they are not inclined to go beyond reason is seen when we consider that in the two years of the plan it has never been necessary for the Cabinet to attempt exercise of the veto power. It is certain the operation of industrial democracy does make them see that the company has rights and problems, just as much as the men, and that the interests of company and men are in the long run identical. Neither the employers nor the employees would willingly go back to former conditions of rule in this plant. And if everybody is satisfied, what more can be asked in the way of a test?

The Romance of Invention

THE man who increases the material wealth of the world by the ordinary processes of trade, manufacture, agriculture or mining does much for us; and not alone in the material sense, for he provides those of us who have ideas with the wherewithal to work, or even in extreme cases with the inspiration with which to work. But we are not to exalt the successful business man, manufacturer, farmer or miner to the highest pinnacle without inquiring whether there is not some one else to dispute or at least to share it with him. What of the man with the idea? Before ever the miner, to take one instance alone, can extract wealth from the bowels of the earth, the inventor must show him how to proceed. Before any of us can do any of the things that seem materially worth while, indeed, there must be the inventor to precede and blaze the way.

It may be assumed that the ability to invent and the ability to make a practical success out of an invention in the vast majority of cases are mutually exclusive. The whole record of the advance of civilization shows this. The inventor is too wrapped up in his idea to have a very clear notion of just what to do with it. A doubly unfortunate result follows; unfortunate for the community in that the invention is not developed and got into general use for the common good to the full extent of its capabilities, unfortunate for the inventor in that he fails by this very circumstance to get his full reward.

Sometimes, however, we meet a man who combines in his one person the qualities which lead him to make a great invention and at the same time make him able to carry it to commercial success. Such a man embodies to the last degree the romance of invention—for romance has a wooden leg when it does not end happily. And of such a man, his struggles to overcome scientific and industrial obstacles, and his final success, we read with never-flagging interest.

The SCIENTIFIC AMERICAN has decided to present the stories of a number of Americans who have produced an invention of the first rank and succeeded in "making it go." The series will cover men whose names have become household words, and others of whom the general public is largely in ignorance. But they will all be inventors who, by virtue of the scientific importance of their work and the financial success which they have attained from it, offer an inspiration to every man who is smarting under the lash of an idea.

The series will be prepared by Mr. C. H. Claudy, our Washington correspondent. Mr. Claudy is almost too well known to our readers, by virtue of his fine work in Washington and more recently in Europe, to require any introduction other than by name. His series commences in the present issue with the story of Bell and the telephone, which will be followed from time to time by the other titles.

To Our Subscribers

OUR subscribers are requested to note the expiration date on copies of SCIENTIFIC AMERICAN. If they will send in their renewal orders at least two weeks prior to the date of expiration, it will aid us greatly in rendering them efficient service.

Electricity

Canadian Amateur Wireless Stations were reopened on or before May 5th last, for on that day the order was issued permitting all amateurs to resume their activities as in pre-war days. Canadian wireless amateurs were not permitted to operate their apparatus for over four and a half years, which is a mighty long time as amateur wireless goes.

Development of the Army Searchlight.—A review of the work of the Army Engineer Corps in the war, first issued by the War Department, says that the corps produced a new form of searchlight more powerful than any that had preceded it in any army, with which the Second Field Army had been partially equipped. "It weighed," the report says, "one-eighth as much as lamps of former design, cost only one-third as much, was about one-fourth as large in bulk, and threw a light 10 per cent stronger than any other portable projector in existence." Still further to perfect the searchlight, our engineers were at work on a remote control when hostilities ceased.

Tumbler Switches.—While the tumbler switch has long been the standard in most countries abroad, the United States has persistently stuck to the snap switch and the push-button switch. Of late, however, the advantages of the tumbler switch have come to be realized, and manufacturers have started in on the production of such switches. Some of the designs offered are typically English, while others are distinctly American in their simplicity of design. The new switches of the tumbler type are exceptionally attractive in appearance and convenient to use. A single button operates the mechanism which is of the quick make-and-break variety. Incidentally, the tumbler switch is self-indicating, the position of the lever indicating whether the switch is "on" or "off" at a glance.

Belgium's Need.—In Belgium the telephone and telegraph system is owned by the Belgian Government. During the German occupation a great quantity of material and accessories was destroyed or taken away by the enemy, so there is a great need of material at the present time. American firms who wish to make offers for the sale of electrical apparatus or other material for telegraph and telephone installations might be interested to know that bids should be submitted to the Administration des Telegraphes et des Telephones, Hotel des Postes et des Telegraphes, Place de la Monnaie, Brussels. Each bid, according to official information just received at the American Consulate in Brussels, should be accompanied with descriptions, photographs, etc., when it has to do with apparatus. As for cables, specifications must be given, and whenever possible samples should be sent.

X-Ray Tests for Metal Castings.—The use of X-rays for disclosing defects in materials like steel and timber was discussed at a recent meeting of the Faraday and Roentgen Societies, presided over by Robert Hadfield, who some time ago initiated experiments in radiometallography at the research laboratory of his firm at Sheffield, England. It is claimed that one obvious application of X-rays is to the examination of metal castings for defects, such as blowholes, which can not be revealed by external inspection and yet may seriously impair the strength of the finished article. If the castings are not too large, each of them may be subjected to routine testing by the rays, and blowholes occurring at regular intervals eliminated. The rays may also be employed to study the effect of adding different quantities of aluminum to steel and thus ascertain the proportions needed for sound castings. Rough analysis of different steels is also feasible. Mr. Schneider, at whose plant much work in radiometallography has been carried out, suggested that if a number of carbon-steel and tungsten-steel bars had been accidentally mixed up they might be quickly sorted by means of X-rays, the radiographs obtained with carbon being blacker than with tungsten steel, because the rays penetrate the latter less freely than the former, owing to the lighter atomic weight of the constituent tungsten. At present only a few inches can be penetrated, but great improvements have been made by the Coolidge X-ray tube, and further advances may be looked for not only in this portion of the apparatus, but also in the methods employed for detecting the rays after they pass through the material under investigation.

Astronomy

Diaphragms in Double-Star Observing.—In his recent book on "The Binary Stars," Dr. R. G. Aitken discusses the question of stopping down the object-glass of a telescope with a diaphragm in observing double stars. He concurs in the opinion of Burnham and Schiaparelli that a good object-glass is not improved by this process. In a review of Aitken's book, Prof. E. E. Barnard remarks that while Burnham did not believe in reducing the aperture of the objective, he often used a small diaphragm over the eyepiece, thus cutting down the beam before it entered the eye. Professor Barnard states that this plan is often very useful in reducing the glare about a star.

A Huge Work on Variable Stars.—The *Astrophysical Journal* publishes a comprehensive review of a monumental work on variable stars, the first volume of which has lately appeared in Germany. The work was edited by G. Muller and E. Hartwig, and published under the auspices and at the expense of the Astronomische Gesellschaft. This "History and Literature of Variable Stars" was planned in 1901 and represents the joint labors of many distinguished astronomers. It describes 1,687 variables, of which 838 are found in the first volume. About half a page, on an average, is devoted to each star, including a complete account of its physical features, history of observations of its variability, and bibliography. Two more volumes are to appear.

Observations on the Solar Corona.—A report by Campbell and Moore on photographs of the solar eclipse of June 8th, 1918, obtained at Goldendale, Washington, was presented at the last meeting of the Astronomical Society of the Pacific. It is stated that the short polar streamers of the corona may be in fair agreement with the magnetic lines of force of the sun, assuming the magnetic and the rotation axes of the sun to be in approximate coincidence. The other coronal streamers, however, especially those of the inner and middle corona, are not in harmony with such magnetic lines. The forms of the inner coronal streamers seem to be controlled from local centers occupied by solar prominences. Nearly all of the larger prominences and some of the smaller are enclosed by hooded coronal forms, which extend in some cases at least 10 or 15 minutes of arc from the sun's edge. There is certainly an intimate relation between the hooded coronal structure and the prominences; the same forces evidently control both.

International Astronomical Union.—The American Section of the proposed International Astronomical Union held a meeting in Washington, June 23d-24th, to consider final reports and recommendations preparatory to the sailing of the American delegation to the Brussels meeting of the Union (July 16th). This delegation is headed by Prof. W. W. Campbell, director of Lick Observatory. The International Astronomical Union represents only one phase of the reorganization of international science, which is hereafter to have as its directing agency an International Research Council and to include "unions" for the various departments of science. The astronomical body will take over and carry forward the work hitherto in the hands of the committee of the Carte du Ciel, the International Union for Coöperation in Solar Research, the Central Bureau for the Exchange of Meteorological Telegrams, and various other international astronomical organizations. National sections of this Union have been appointed in various countries by the national academies of sciences, or analogous bodies. The American Section includes one or more representatives each from the National Academy of Sciences, the American Astronomical Society, the American Mathematical Society, the American Physical Society, the Naval Observatory, and the Coast and Geodetic Survey. Within this section a large number of committees have been appointed to consider special topics. Several interesting committee reports were presented at the recent Washington meeting. Among the projects under consideration is the publication of an abstracting journal and annual review of astronomy, to replace the *Astronomuscher Jahresbericht*. It is proposed that this shall be published by the American Section, with foreign coöperation. The American Section has also drawn up tentative suggestions concerning the reform of the calendar, and many other matters.

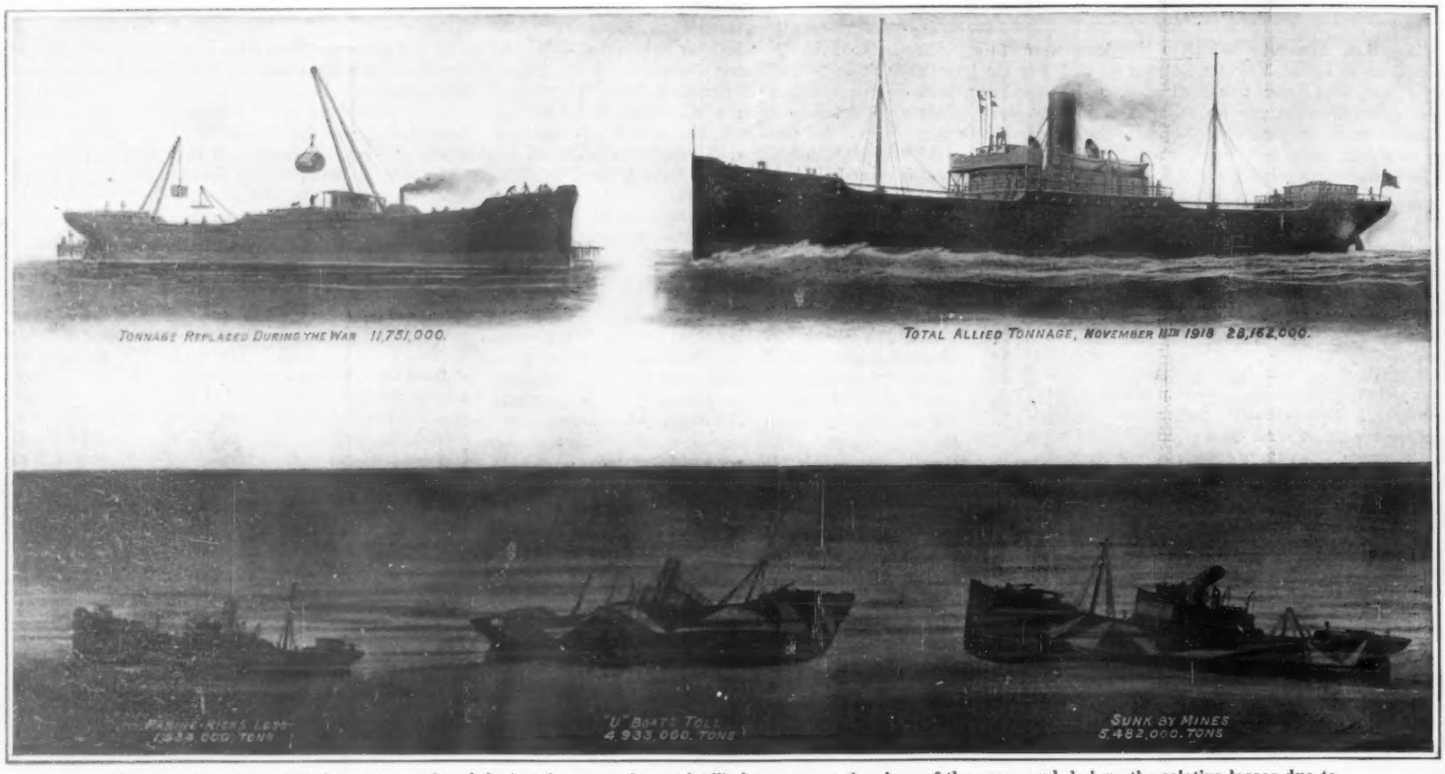
Industrial Efficiency

How to Choose Overalls.—The next time you buy overalls, states the *N. C. S. Bulletin*, get a safe pair. Any make, style, or color will do, but—they should be of the one-piece kind (like a union suit); they should button snugly at the wrist if worn with sleeves; they should not have loose flaps or ends likely to catch in machinery; buttons should be carefully fastened and buttonholes should be strongly made; they should be carefully fitted and should be the right length without turning in.

Factory Reproductions of Rare Eastern Carpets.—Carpets now on display in a London shop will, in the opinion of the *Times*, surprise those who are unacquainted with the strides made in the manufacture of carpets by British factories during the war. The carpets are claimed to be exact reproductions of rare Eastern carpets and are being offered at prices not much higher than those of ordinary loom production. The most remarkable feature about them is considered to be the true rendering of that eastern luster which has hitherto defied successful copying. Some of the most notable reproductions are those of the seventeenth century coronation carpets which were made for the Shah of Persia; the Khorassan rug, and the famous carpet manufactured for the Sheik Ismail, the original of which hangs in the Victoria and Albert Museum of London; and there are copies of others from the cathedrals and art galleries of the world. The carpets vary in size and have all been made in a British factory during the past three or four years.

Moving Pictures and the Safety Movement.—Early in the work of accident prevention the Safety Committee of the United States Steel Corporation realized that a very large percentage of accidents was due to carelessness or thoughtlessness on the part of the workman himself, with the result that an active campaign was begun to educate the workmen in safe methods of doing their work. These activities extended in many directions, including the taking and showing of motion pictures in order to visualize to the workmen safe and unsafe practices. The first moving picture was taken in 1912 and is entitled "An American in the Making." Besides showing many safety devices, it illustrates to the foreigner the opportunities afforded him for the betterment of his condition. The second picture, "The Reason Why," was taken in 1917. It consists of two reels of 1,000 feet each, and also illustrates safe and unsafe methods of doing work. The third picture was taken early in the year 1918, and was given the title "Why." This fills two reels of 1,000 feet each, and might be regarded as a continuation of "The Reason Why." These pictures have been shown to thousands of employees, in all classes of industry and in all sections of the United States and undoubtedly have had a very beneficial effect.

Development of Canada's Oil and Helium Resources.—Canadian commercial enterprise is again before the British public in the form of two announcements made by the Canadian Mission in London, the first being that exploitation of the oil fields of western Canada on a large scale is in contemplation. It is stated that one company has applied for the sole right to exploit 250,000 square miles in northern Alberta and the Northwest Territory, and has suggested the condition that within five years of signing of the peace treaty the company shall choose 25,000 square miles in northern Alberta for its operations, the remainder reverting to the Government. Another company has applied for permission to explore 3,600 square miles on condition that the Government grants it two years' geographical survey and three years' exploitation, and it offers to pay the Government 12½ per cent on all oil produced. The second announcement of the Canadian Mission refers to the discovery in large quantities in western Canada of helium, the lightest known gas after hydrogen, which is more suitable than the latter for filling airship envelopes, as it is non-inflammable and non-explosive. In the course of the investigations undertaken by Professor McLennan of Toronto University during the war to see what supplies of natural gas could be found within the Empire, it was discovered that large quantities of helium could be obtained from the natural gases available in Canada.


TONNAGE REPLACED DURING THE WAR 11,751,000.
TOTAL ALLIED TONNAGE, NOVEMBER 11TH 1918 28,162,000.
MARINE RISKS LOST 1,934,000 TONS
U BOATS TOLL 4,933,000 TONS
SUNK BY MINES 5,482,000 TONS

This drawing shows Allied tonnage replaced during the war; the total Allied tonnage at the close of the war; and, below, the relative losses due to marine risks, U-boats and mines

Effect of the War on the World's Shipping

(Continued from page 51)

loss of 3,885,000 tons, and that at the signing of the Armistice, November 11th, 1918, her total tonnage was 15,006,000 gross tons.

But if Great Britain was by far the largest loser through the war, due to the fact that she served as the great carrier for the Allies, the United States, on the other hand, came out of the war with a gain in tonnage approximately equal to the English loss. On August 1st, 1914, we had 1,076,000 gross tons of shipping; we lost 700,000 tons; we built and took over from the enemy 4,100,00 tons; and at the Armistice we had a total of 4,476,000 tons, coming out of the war with an actual net gain of 3,400,000 tons of which about 600,000 tons is represented by the fine German ships which were shut up in our ports by the Allied fleets on the day that war was declared in 1914. The bulk of our increase is due to the vast program of ship construction which we put in hand to meet the submarine menace. The effect of the war on our relative standing has been to raise us from the position of ninth to second position among the maritime nations.

Germany, in 1914, possessed 5,135,000 tons of shipping; her losses amounted to 2,700,000 tons; her replacement by new construction and seizure of enemy ships was 950,000 tons; and her fleet at the time of the Armistice amounted to 3,385,000 tons, leaving a net loss of 1,750,000 tons. . These figures it must be remembered are for the date of the Armistice only. The maritime reparation exacted from Germany by the treaty of Versailles, in which she has to make good, ton for ton, for the shipping unlawfully sunk by her U-boats, to say nothing of 200,000 tons of shipping which she must build each year as replacement for the Allies, will practically wipe out her existing fleet.

The war has benefitted Japan only less than it did the United States; for with the elimination of the German merchant fleet, she stands third in the list of maritime nations; her 1914 fleet totalled 1,708,000 tons; she lost 275,000 tons; she built 885,000 tons and in November, 1918, possessed a total of 2,318,000 tons, showing a net gain of 610,000 tons.

Next in present standing to Japan come the British Colonies, which lost 275,000 tons; replaced 475,000 tons; and increased their merchant fleet from 1,632,000 to 1,832,000 tons—a net gain of 200,000 tons.

Holland, which in the material sense played very, very safe during the war, showed at its close a net gain of 335,000 tons; her total fleet increasing from 1,472,000 to 1,807,000 tons. Her replacement was large, 560,000 tons.

Norway, on the other hand, whose sympathies were notoriously with the cause of civilization, paid the price, losing 1,175,000 tons out of 1,957,000 tons. In spite of a replacement of 775,000 tons, she came out of the war with only 1,557,000 tons, incurring a net loss of 400,000 tons. She has dropped from third to seventh position.

France was also a heavy loser; she had 1,923,000 tons in 1914; lost 905,000 tons; replaced 425,000 tons. With a net loss of 480,000 tons she came out of the war with 1,443,000 tons.

Even heavier was the blow which fell on Italy's merchant marine. At the outset of the war she had 1,430,000 tons; of this she lost 875,000 tons; her replacement was 375,000 tons, and she finished with only 930,000 tons, having lost a total of 500,000 tons.

Directing attention now to our drawings on this page our artist has brought out a fact which will be surprising to most of our readers, namely, that the largest Allied losses were not due to submarines but to mines, which are credited with having sunk a total of 5,482,000 tons of shipping during the war. The losses due to U-boat attack, though they are very large, are over half a million tons less than those due to mines—the total being 4,933,000 tons. The smaller vessel of the three shown lying at the bottom of the sea represents the ships whose loss was due to what is called "Marine Risks," which accounted for 1,934,000 tons. It should be noted that in the later period of the war the U-boats were very active minelayers.

The upper pair of ships show graphically what stupendous efforts were made, in Allied shipyards and by the putting into service of seized enemy ships, to keep pace with the frightful rate of loss. The total replacements of all the Allies was 11,751,000 gross tons, and the total Allied tonnage at the date of the Armistice was 28,162,000 tons.

Finally the summing up of the world shipping situation by Mr. Henry .C. Wiltbank in the article in *The Rudder* above referred to, gives the following results: total world tonnage in 1914, 42,146,000 tons, total world losses during the war 18,286,000 tons, total world replacement 15,049,000 tons; the total world net loss 3,237,000 tons, leaving a total tonnage for the world on November 11th, 1918, of 38,909,000 tons.

Leather Belt by a New Process

AN extremely interesting invention has been reported from Italy which, we may remark, is based upon the somewhat astounding maxim that the more a hide is tanned the less resistant does it become. In support of this statement mention is made of the numerous pieces of leather found in ancient Egyptian stables, etc., which have successfully resisted thousands of years exposure to the attacks of destructive agents of all kinds. Now all these leather goods were made of parchmented leather. In modern times samples of this class of leather may be cited in the case of the lashes of hunting crops, the hinges of flails, etc. The inventor, M. Felice Gilardiri of Turin, having studied the enormous resistance of parchmented leather to traction, proposed to apply this quality to driving belts but to effect this, as parchmented leather has no elasticity, it was necessary to find a process obviating this difficulty.

The solution of this problem is both elegant and ingenious; it consists of combining in the leather itself both the qualities of vegetable-tanned leather with those of parchmented leather. By means of considerable pressure there is indelibly impressed in the hide a pattern resembling the metal trelliswork used to form fences. At the point where the pressure has been exerted, the hide becomes absolutely indifferent to any tanning material whatsoever. This result obtained, the hide is tanned and only those parts in the interior of the meshes formed by the impression are transformed into leather, properly so-called. The interior of the meshes thus forms "compensation chambers" so to speak, with a very elastic character, whilst the trellis pattern surrounding them offers an enormous resistance to traction. As these two qualities coöperate to obtain one common result, a driving belt of such resistance is secured that very considerable horse-power can be transmitted with far narrower belts than is now possible. Leather in crust and horsehide can be used for making these belts, tests with which have given such excellent results that they are now already largely used in Italian industrial establishments.

Salvaging Trench Hose Pipe

AN interesting side line of war salvage is being carried on at Hayes, Middlesex, England, where some hundreds of miles of trench hosepipe are being disintegrated and the various products recovered for sale. This type of hose contains a large amount of iron wire and canvas impregnated with a small proportion of rubber. A special machine has been designed for treating the hose, and the stripped wire is stated to be worth about £15 a ton at present prices. The rubber is being reclaimed, and the canvas ultimately finds an application as cellulose. The work is being done on a part of the premises of a detinning works, where considerable quantities of scrap tin are now being treated by the electrolytic process with satisfactory results. Tin metal of a high standard is being obtained from the scrap, containing as much as 99.8 per cent of pure tin.

Precautions That Spelled Success

Some Engineering Features of the First Flight Across the Ocean

By James L. Breese, Jr., Lt. U. S. N. R. F., Chief Engineer of the NC-4

LT. JAMES L. BREESE, Jr., was in charge of the design and installation of the power plant of the NC Division of Seaplanes, which was designed specially for the transatlantic crossing. Lt. Breese was also the Engineer Officer and Reserve Pilot of NC-4 on the transatlantic trip. —EDITOR.

WHILE much has been written about the pilots and the design and development of the NC type seaplanes, little has been said about the power plant, and it has been more or less taken for granted that all that was necessary was to start the engines and let them run till they were out of gas. It is my intention in this article to show, first, the problems which were confronted in developing a multiple-engine power plant, and, second, the way in which these problems were solved.

At the outset it was realized that the NC, as originally designed with three engines, could make the longest leg of the flight, namely, from Trepassey Bay to the Azores, but, if any engine trouble developed on the way, the machine could not be kept up with two engines. It was therefore decided to make the power plant a four-engined job. There were two arrangements open, namely, a double tandem installation, where two engines were mounted, back to back, in each wing, rotating in opposite directions, or three tractors and one pusher.

The advantages claimed for the first layout were low-head resistance, two identical units, saving of weight, and the maximum in accessibility, as the center of the machine was left clear of all propellers. The objections were, first, that the rear propellers were inefficient when working in a wind stream, and particularly so at the time of taking off the water; second that running on any three engines would be an unbalanced condition; third, that the system of tandem was too new to trust for such an important flight; and fourth, that all propellers were working in the spray when on the water.

The other arrangement was three tractors and one pusher. The advantages claimed for this were: Three slip streams as compared with two in the other; flexibility of power plant, that is either of the center engines could be cut out, and still the machine would be in perfect balance; maximum thrust at the get-away, and protection from spray for the two center propellers.

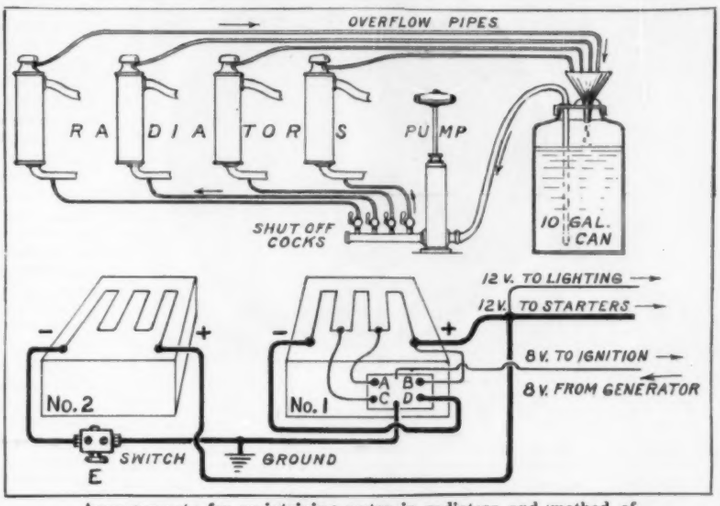
The objections were: greater weight and inaccessibility of power plants with engines running; the pusher propeller cutting off access from the rear, and the center tractor access from the front. This latter arrangement, however, was chosen and is clearly shown in one of our illustrations.

After the general arrangement of engines was definitely agreed upon, the problems of interconnecting each engine, so that it would function either as an entirely separate power plant, or, in the case of an emergency could draw on the other power plants or from a central source within the hull. The problems treated were: Supply of (a) gasoline, (b) oil, (c) water, (d) current for ignition, and (e) current for starting.

(a) The gasoline was supplied from a central system. Four wind-driven pumps mounted on deck, and just outside the engineers' cabin, forced the gasoline up to a 90-gallon tank in the center wing panel. From here separate leads went to each engine. The tank had an overflow pipe, with a sight glass, so that by regulating the pumps, the tank could be kept just overflowing at all times. Two pumps could easily handle this supply, while the other two were held for emergency. The main tanks, of which there were nine, located in the hull, held 200 gallons apiece, and the gravity tank about 90 gallons A gage glass, connected to the main fuel line and located in the engineers' cabin, showed at all times the amount on board.

(b) The oil supply was taken care of by a separate tank, mounted integrally with each engine installation in the case of the port and starboard engines, and one tank for the two center engines. The outboard engines had a capacity of 40 gallons apiece, and the center tank 80 gallons. In addition to this, pipes were run to each tank, and a pump installed below and operated by the engineer, so that spare oil could be carried in cans and forced up, if it was found to be necessary while the dirigible was in flight.

(c) Water for cooling was carried in the usual way in the radiator—a separate radiator for each engine. In addition to this, an auxiliary supply system was installed, making it possible to fill any radiator during flight, and to catch the overflow at all times. This system worked very satisfactorily and it was found that, if the radiators were once filled and the overflow caught, no additional water was needed except in the case of a leak, and for this we used bilge water, of which we always had enough in the hull.



Arrangements for maintaining water in radiators and method of hooking up the batteries

(d) and (e) Current for ignition and starting was supplied by two large 12-volt batteries, despite the fact that the 70-ampere-hour ignition was an eight-volt system. This eight-volt system caused us all sorts of trouble and annoyance and was always a source of worry, as the generators were also eight volts and we were always running down two out of the six cells. We finally hooked the batteries up in the following manner and obtained fair results:

Battery No. 1 was the regular service battery, while No. 2 was just used for starting and was to be thrown overboard if necessary, or used for lighting at night when in port. It was easily removable and was used entirely in the manner of a spare. No. 1, however, was so wired that it would take the charge while flying, and could be kept in service indefinitely if the engines were run sufficiently. It will be noticed that switch E is in the ground circuit, as is also C and D, while A and B are in the positive side. Now the combinations we used are as follows: (1) E open, A closed and D closed. In this position the circuit is set for 12 volts starting, 12 volts lighting, eight volts ignition, and eight volts charging the four left-hand cells.

(2) Same as above, except B closed instead of A. This gives 12 volts ignition for extra lot spark for starting only, no charging.

(3) E open, A and C closed. This is the same as (1) except the right end of the battery is charged; there is no 12-volt current available for lighting. This cannot be used when flying at night.

(4) E closed, the rest open, used for lighting only while at anchor.

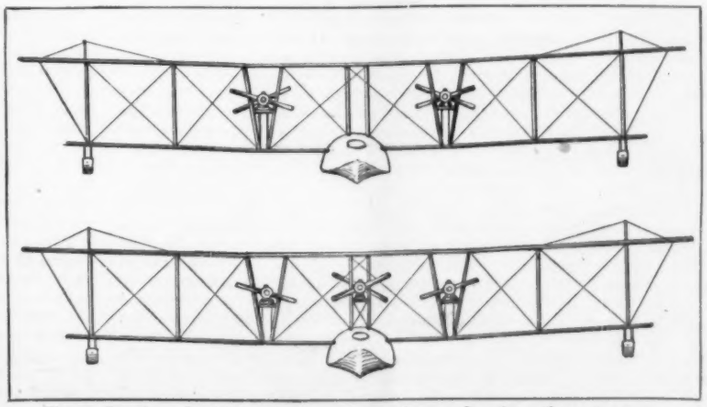
(5) E closed and No. 1 combination used when both batteries were low and could not be recharged.

With the above-mentioned interconnecting systems we could therefore operate perfectly with a broken pump, and a dead generator, any one of these occurring during flight in any of the four engines. As a matter of fact these auxiliary systems were very little used, and when we arrived at Trepassey Bay and prepared for the "big hop," the greatest problem was what was the minimum amount of gasoline we could carry and still make the run.

We had tankage for 1,900 gallons; but, had we filled up completely, we would have been over weight, and could not have got off. On the two short legs up to Newfoundland, it was found that the gasoline consumption was running about 84 to 88 gallons per hour. We therefore decided that, if we put in 1,600 gallons, we could make our weight (the limit of which was 28,000 pounds) and still count on 18 hours flying. This gave us a safety factor of one hour; as a fair estimate was 17 hours for the 1,200 nautical miles figuring an average of 70 knots speed. As a matter of fact NC-4, the only boat to complete the run, and of which I was chief engineer, gave the following results.

Trepassey to Azores, including 15 minutes waiting in the air for NC-3 and 1 to get away and 1 hour and 30 minutes from Horta to Ponta Delgada 17 hours, gasoline consumed was 1,469 gallons, which gives a consumption of 86 gallons per hour for 17 hours, with enough left for a little over one hour. Our consumption of oil was 6.4 gallons per hour for all four engines, which was very high but what we had figured on. The gasoline and oil consumption figures for the rest of the trip check substantially with those given above, and, as the "hops" were shorter, are not as accurate.

A summary of the results for the entire trip from Rockaway, L. I., to Plymouth, England, is given in the table on page 74.



Upper drawing, double-tandem engines. Lower drawing: three tractors and one pusher (adopted)

Making Surplus Munitions Serve the Cause of Science

AN interesting suggestion has been made by a prominent Swiss meteorologist and physicist, M. de Quervain of Zurich, to the effect that the vast stores of munitions collected in the belligerent countries during the last four years be utilized to advance the cause of science instead of being merely fired off to make a Roman holiday, or else sunk in deep waters to avoid the latent dangers which reside in them. By detonating these explosives in definite quantities, at definite places, and at definite times whose dates are announced in advance, a possibility would be presented for the solution of many interesting problems in physics and meteorology. The project might advantageously be carried out in this country.

The Romance of Invention—I

In 1876, One Patent; In 1919, Eleven Million Telephones

By C. H. Claudy

AT the Centennial Exhibition in Philadelphia, in 1876, a young man exhibited a novel toy, on which, to the laughter of his elders, he had "squandered" money in taking out a patent.

The man was Alexander Graham Bell. The "toy" was the first telephone.

Today there are 8,041 different patents on telephones, telephone systems and telephone apparatus of all kinds, not including those which relate to wireless telephony.

Of these, Dr. Bell had only two—the first patent in 1876 and his second a year later, an improved form of his first invention. Yet on these two patents has been erected a commercial structure girdling the world with its product. From them has sprung a means of communication without which the modern world could not function. The other 8,039 patents have carried the original invention to a state of perfection of which the inventor of the first telephone could have no more than dreamed—not his the credit for the automatic telephone, the extraordinarily sensitive instrument of today, the great trunk line systems, the exchange, the modern circuits, all the complications and extensions of telephony which thousands of brains have perfected. Yet his the credit for the original invention, spite of a hundred efforts to take it from him, and his, by proxy at least, the credit for all that any inventor has done, since; without his rock-bottom, fundamental patent as a basis telephony would not be.

Just how great an industry thus rests first on two, and then on 8,041 patents (it may be 9,000 by the time this story gets in print) is seldom realized by him who hourly picks the receiver from the hook. Ask the man in the street how many telephones there are in the United States, how many telephone calls we make a year, how many people are employed in telephony, how many companies there are, how many miles of wire? Then compare with the real figures and see how far short of the staggering total his or your imagination may be.

No one knows how many telephones there are at the present moment. They keep multiplying far too fast for any census to keep up, but at the close of 1917 there were 11,713,228 telephones in the nation. That is one to every nine persons, one to every two families.

As for the telephone calls, the total is 21,842,000,000 which means more than 200 for every man, woman and child in the nation.

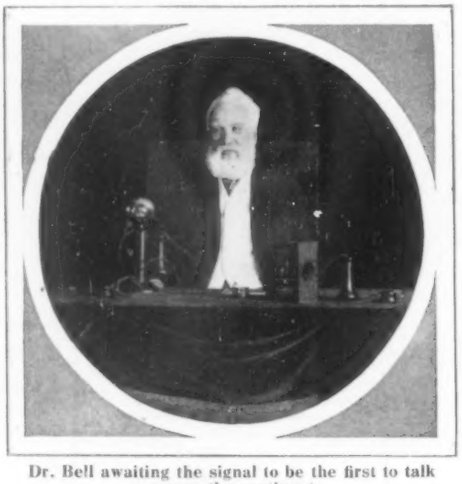
Many people will recall the little toy apparatus of 1876 and remember laughing at the idea that a man would have a *thing* in his office into which he would talk. The telegraph was all right—people did have to notify others quickly of death and disaster and of course newspapers had to have it. But what was the use of being able to *talk* over a wire? And did anyone think anyone could talk into a box, anyway, and not expire from laughter on the spot? The young man was very ingenious, of course—but put money into a thing of that kind? Not any. One wonders what they think now, these who were so wise?

To buy all the telephone systems you would have to float a Liberty Loan! The value of the plant and equipment alone was placed at $1,492,230,081 in December, 1917. Telephone companies paid then an annual salary list of $175,668,299 and out of a total income of $391,746,000 disbursed a total of $319,000,000 in expenses and fixed charges.

When Dr. Bell first took his invention to business men they couldn't "see it" at all. Their only conception of its possibilities was that it might make a moderate profit, if there could be generated a demand for *the sale of the instrument*, at a few dollars each. Even after a company was finally formed, by some venturesome gentlemen who were willing to risk a little on the "toy," they still held to the idea that it must be manufactured and sold outright. Mr. Hubbard, Dr. Bell's father-in-law, however, thought differently. Interested in the company because of his interest in the young inventor, he had visions. Perhaps it was not of the telephone as we have it today, but it was a clear enough conception for him to realize that the profit in telephony was not in the *thing*, but in the service, and that the money was to be made not by selling instruments but by maintaining a plant, lines, a central office, and charging rent for the individual phone.

It has been a wonderful story, this romance of the telephone. It is easy to recall when it was a triumph of telephonic engineering to get a clear wire 50 miles in length. Now we telephone across the continent, and transoceanic telephony is not an impossibility. It is but a few days ago that the corner drug store counted its telephone as among its assets to draw trade—now every other house possesses one as much as a matter of course as it possesses light and heat. In the beginning there was one feeble little commercial organization known as the Bell Telephone Company. Today the Bell system has 145 operating companies; besides these are more than 2,000 systems reporting an annual income of more than $5,000 and more than 50,000 small systems reporting an annual income of less than $5,000. Altogether there are 28,827,091 miles of telephone wire in the country and, most remarkable of telephone figures, any Bell subscriber can talk over practically any of 23 million miles of wire he wishes.

More than a quarter of a million employees care for and operate these telephones and miles of wire, and an unguessed number are occupied in cutting poles, making wires, manufacturing instruments used by this spider's web of speech which nets the United States into a closer whole than ever the railroad did or could.



Dr. Bell awaiting the signal to be the first to talk across the continent

How the art has grown is best exemplified in how the commercial extension of telephony has grown. The 10 years which passed between 1907 and 1917 saw the number of systems in existence more than doubled—the increase was 130 per cent. The miles of wire increased by 121 per cent, the number of telephones by 91 per cent (wire always grows faster than instruments) the phone calls almost doubled, 92 per cent, the employees increased 82 per cent, salaries and wages jumped 157 per cent, income 112 per cent, expenses 126 per cent and value of equipment 80 per cent.

The Bell Telephone System reported, for 1917, 62.6 per cent of the total number of telephones, 80.3 per cent of the total wire mileage, and 76.4 per cent of the total value of plant and equipment. In addition to the 7,326,862 telephones directly owned by this system, there were 3,164,902 independently owned telephones which were connected with the Bell lines and exchanges for the interchange of local and long distance service. The Bell service, therefore, reaches 10,491,764 telephones, or 89.6 per cent of the total number reported.

There have been a great many instances of people who have invented or discovered things of the greatest possible benefit to humanity at large, who have profited little or nothing from their labor. Many an inventor has lived to see others reap the reward of his work and died of a broken heart, if of nothing more sordid, because he was unable to make a commercial success of the child of his brain.

Dr. Alexander Graham Bell says of himself that he is not a business man, and that he has no interest in the commercial side of an invention. But he was so fortunate as to have associated with him in the early days of the telephone, men who were able business executives and who not only made the telephone a commercial success but safeguarded the inventor's interests so that he, too, received benefit from the commercial side of his invention. Today, 72 years young, Dr. Bell is keenly interested in science and invention and is hard at work on many different problems, though no longer engaged in telephone research.

The genesis of the invention of the telephone is intensely interesting. Inventions or discoveries are all in one of two classes—they are either accidental or they are the direct result of experiment and investigation, trying to find a means to produce a result the possibility of which has first been admitted in the mind.

The telphone was of the latter class, as indeed, many of the great inventions of the world have been, air brake, cotton gin, electric light, reaper, etc.

The theoretic possibility of the electric transmission of sound over a wire was probably realized before Morse demonstrated that signals could be sent. But to recognize that a thing is possible is one thing—to do it is quite another. Thus Langley knew that mechanical flight was possible—he even accomplished it with a small model (and by the way, that historic first flight of a heavier-than-air flying machine was both witnessed and photographed by Dr. Bell, who has ever since been intensely interested in aeronautics and has himself contributed largely to its advancement). But Langley didn't know how to get his machine into the air. Reis had experimented with a make-and-break current in the mistaken idea that the voice could be thus reproduced. *Sound* can be so reproduced, but not *speech*. Dr. Bell conceived the idea that if an undulatory current could be produced, which was continuous, not intermittent, which would follow in its fluctuations the fluctuations caused by a human voice, it might reproduce that human voice at the other end of the wire.

At the same time he was experimenting in a field which all his life has been that nearest his heart—the aid and instruction of the deaf and dumb. He was endeavoring to produce, by transcriptions of the human voice through a vibrating dipahragm and needle, a record which could be read visually by the deaf. But a comparison of such records, made on smoked glass, with the formations of the manometric flame, under the influence of the voice, showed him that his apparatus must be far more delicate and responsive if it was to be accurate. So he asked a surgeon to teach him more about the human ear that he might make a diaphragm as small, as sensitive and as accurate as the ear drum.

"Why not use a real ear?" suggested the surgeon.

"Get me one," was Dr. Bell's answer.

"So he got me one." Dr. Bell tells the story with much interest. "He got me a human ear and cleaned it up nicely. I attached my little bristle to one of the small bones, made an ear shell, and there I would sit, shouting into that dead subject's ear by the hour together, getting records. Then it occurred to me one day to wonder at the fact that the tiny little drum could move the relatively heavy bones of the ear as it did. And if an ear drum could move a bone many times its own weight, why couldn't a diaphragm membrane move a relatively heavy piece of iron? And there I was, at work again on my other line of work, and the sensitive diaphragm with the little piece of soft iron vibrating in front of a magnet was the result—and the principle of the telephone was established. A year later I eliminated the battery and substituted an all-iron diaphragm for my membrane with an iron center, but the principle remains the same—the undulatory current which reproduced similar vibrations in a similar apparatus at the end of a wire."

Dr. Bell knows a thousand stories of the telephone and its early days. "You ask for telephone stories. I'll tell you one," he said to the writer. "You know of course, that the telephone is used in surgery, in connection with locating foreign bodies in the body? Well, last summer we lost a whole boatload of iron in the water near Nova Scotia. Boat upset. And of course there wasn't any way of marking just where it was. So I hung a brass bar at the end of a telephone wire, connected it up, and dragged for the lost cargo. And we located it very nicely with my submarine telephone surgical probe. I think it was quite fitting that the inventor of the telephone should use it that way. Later I'm going to try to locate a wrecked iron ship the location of which no one knows—the same way, of course."

Thus the telephone story—a single patent 43 years ago—a world-girdling system of wire and instruments today. Eight thousand and some patents in the patent office, billions in money resting on the industry they created—and the one man responsible for it all using his own invention to find a lost cargo, and much of the money he has made out of his brains to investigate other problems—boats, aircraft, longevity, helping the deaf and dumb.

Using the telephone is as commonplace as breathing. But give the magic of the growth of the industry which sprang from one small patent a thought, next time you lift the receiver and call for a number.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Oil From Shale

To the Editor of the SCIENTIFIC AMERICAN:

The publication in your issue of May 10th of an article written by H. L. Wood upon "Shale Oil as a Business Proposition" is timely. The question is of such importance that you will, I am sure, permit one who has given nearly 10 years to its study to discuss the question further.

Whether the admittedly very large deposits of oil-yielding shales are to become of economic importance as a future considerable supply of hydro-carbon oils depends almost entirely upon a satisfactory solution of the present retort controversy being arrived at.

The Scotch oil-shale engineers still cling to that form of a retort commonly known as the Scotch retort, a retort the result of commercial, financial and industrial conditions, special to Scotland, but which do not exist in the States nor in Canada. This retort is designed for the dual purpose of recovering the nitrogen contents of the shale, as well as the oil contents.

Experience has caused most engineers to dislike dual purpose machinery. Such machinery is always more expensive to construct and is seldom as efficient.

The debatable question of whether a dual purpose retort should be used to retort the shales of the States and of the Dominion of Canada is one that can hardly be argued in a letter. The Scotch engineers claim that it should be, others who have studied and have cognizance of the local conditions, commercial, financial and industrial, as they exist in the States and in Canada, say it should not be, excepting in a few but limited number of special cases. This opinion is held strongly by many experimenters, who are producing different types of single purpose retorts. The time will soon arrive when it will be possible to test the best of these single purpose retorts against the already perfected dual purpose Scotch retort. Any one who understands local conditions can have no doubt as to the ultimate result.

No reliable comparison can be made of the respective cost of the several retort plants, unless it is first understood what machinery and accessories such cost covers, whether running and assembling machinery be included, and also what machinery and plant, after the oil gases have passed through the condensers.

Not only may the running and assembling equipment required be, at times, very costly, but the cost of storage tanks, pipe lines, etc. Sidings may add considerably to the total. In some cases the construction of roads and of wharves have been included. It may, however, be accepted that the cost of a dual purpose Scotch retort, per ton of shale retorted, will be, at least, four times that of the best examples of the single purpose retorts.

The question therefore resolves itself into a determination of whether the profits raised from retorting, say *100 tons* of shale in a Scoth dual purpose retort, will equal or exceed the profits secured, when retorting *400 tons* of shale in a single purpose retort. The question of saving or wasting the nitrogen of the shale at this date cuts no figure, because nitrogen is one of the common gases and can now be recovered from the air at a cost as low as or lower than it can, generally, be recovered from shale.

In Scotland, before the war, the cost of mining and assembling was $1 per ton. It will be much higher now, probably $2 per ton. What the cost will be in the States and in Canada depends upon local conditions. Where the shale can be mined by the use of excavators or shovels, the cost may come very low, certainly less than 50 cents per ton, including the cost of explosives. Where the shale is mined from drifts driven into the side of a mountain, the cost will be governed by the quality of the roof rock, by the thickness of the bed of shale, by the quality of the machinery used, and by the daily tonnage mined, with other minor conditions too numerous to mention.

The low-cost single purpose retort has the advantage that for a stated expenditure, made upon the retort plant, four times the quantity of shale can be mined. The extra quantity so mined secures economy of production. So also with operating the retort. The cost per ton in Scotland, before the war, was 40 cents. It is now probably 80 cents. A retort plant properly constructed and retorting 1,000 tons per day can be operated with about the same labor as one retorting 250 tons per day. Hence the saving in the labor expended upon the different retorts. Each plant requires a like expenditure of wages, so there will be a saving of no less than 60 cents per ton of shale. As even 25 cents would give a dividend return not to be despised upon a daily output of 1,000 tons, it would seem to be evident that the single purpose retort holds a very strong position.

The best retort is that which will recover the oil contained in the shale at the lowest capital cost, and with the lowest labor cost and which returns to the investor the highest dividend upon the money invested.

For some time I have been of opinion that the ideal size for a retort plant is 1,000 tons throughout. That 500 tons throughout is permissible, but nothing smaller—but local conditions may warrant, in a few cases, departures from the rule. It will be a surprise to many to learn that in Colorado and Utah the one factor that will control the extent of the developments of the oil shale deposits and the retorting of the oil contents will be the available supply of water This again militates against the employment of the dual purpose retort, because the latter retort requires the consumption of very much greater quantity of water per ton of shale retorted, than does the single purpose retort

LOUIS SIMPSON,
Member American Electrochemical Society.

Ottawa, Canada.

An Alternative for the Metric System

To the Editor of the SCIENTIFIC AMERICAN:

We have before us literature sent out by a society advocating the adoption of the metric system, and asking us to use our influence in bringing about legislation to this effect. We have replied, stating that we are heartily in favor of a decimal system, but cannot altogether endorse the old metric system in full. Particularly we object to the meter itself, the metric unit of linear measurement, on account of its inadaptability to a vast number of operations.

We have suggested the decimalization of our present standard, the inch. This has already been accomplished to a large extent—for the tenth, hundredth and thousandth inch we have measuring instruments such as micrometers and gages, as well as flat scales and rules graduated with tenths and hundredths.

Since the fractional parts are thus already established, why not establish divisions above one inch also on a decimal basis? This could be done with ease by having 10 inches equal a certain named length, 10 of these or 100 inches another named length, etc. By doing this our present measuring system would not be greatly revolutionized, and no effect would be felt on lead screws or on the graduations of our many machine tools and small tools.

There are in the United States and Great Britain and other English-speaking countries, millions if not billions of dollars worth of machine tools and gages built and graduated on the inch basis, and more millions of dollars worth of jigs and special fixtures in machine-tool and tool-builders' factories used to build standard tools to inch standards. These will all wear out some day and have to be replaced; and if it were possible to replace them thus gradually with metric-system equipment the proposed change would not be so bad. But nothing of the sort is possible; you cannot go over to the metric system a little at a time, you must go over all at once. This would involve the absolute abandonment of all this equipment; it would be a tremendous loss and a most impractical thing to do.

By decimalizing the inch we could get very quickly on a decimal basis, at very slight cost and inconvenience. At the same time we would get a more practical linear measuring system than the meter system would be.

The great opposition which the majority of manufacturers have against the metric system is not against the principle of decimalization itself, which is universally admitted to be good, but rather against the meter unit, which is so difficult to change into inches. There is no great hesitancy in abandoning our feet, yards, rods, etc., but we must not, we dare not and cannot, abandon our inches.

The manufacturers look at this from a practical and common sense standpoint, and are desirous of getting the greatest convenience with the least cost and attendant inconvenience. The proposed departure would very little revolutionize our present measuring instruments, and it would not affect lead screws and graduations on any of our present machine tools. We would only need to abandon our present quarters, eighths, sixteenths, thirty-seconds and sixty-fourths, to which we feel very sure that few would object.

To use the metric nomenclature with the inch as unit we would suggest that definite names be given to the lengths from .001 inch, through .01 inch and on up to 100,000 inches. For these we might follow metric precedent and employ such names as milin, centin, decin, INCH, dekin, hectin, kiloin, myrin, tele; or some better suggestion might be put forward. The 100,000-inch unit would equal 1.578 of our present miles and would be a convenient unit for distance measurement to replace the mile. Using the above nomenclature, the square kiloin would equal about one-sixth acre, and would be a convenient unit for ground areas.

We submit the foregoing in the hope that it may help to prevent any serious movement to legalize the meter as the standard unit of linear measurement.

E. S. MUMMERT.

Hanover, Pa.

[*The merits and demerits of the proposition advanced above are clear. It would meet all the demands of the situation except that of international uniformity. It would seem a matter for further discussion whether this is the main advantage to be derived from adoption of the metric system, or whether, as our correspondent tacitly assumes, the chief warrant for a change is simply the attainment of a decimal basis of measurement. In any event, however, the suggestion here advanced is one which cannot be ignored, but which must be considered seriously and on its merits by both its advocates and its opponents. Accordingly, while the* SCIENTIFIC AMERICAN *is not at the moment prepared to state in which of these groups it should be placed, we are bound to give space to Mr. Mummert's letter and to invite expressions of opinion from others.*—THE EDITOR.]

A Question of Credit

To the Editor of the SCIENTIFIC AMERICAN:

In the issue of the SCIENTIFIC AMERICAN of June 7th on page 595, illustration is made of method used for the protection of decoy ships which you fully explained on page 600 of the same issue.

Credit for this is given to Mr. Warren S. Fisher of the Naval Intelligence Bureau. In this connection I wish to say that these plans were submitted to the Naval Intelligence Bureau at the outbreak of the war by a carpenter named T. A. Corr of this place. He submitted model to me as Secretary of the Council of Defense and I transmitted the same to Washington.

Although there were some changes made in his original design, the steel plate protecting the ship by water cushion and handled by a boom, are the very features contained in his model. I believe that due credit should be given to Mr. Corr, who is a working man, for the suggestion which met with the approval of the Intelligence Bureau.

F. E. SMITH.

Bakersfield, Cal.

[*It gives us pleasure to publish this letter and give credit to Mr. Corr. The use of steel plates, carried on booms, was suggested by many correspondents of the Scientific American, during the progress of the war, and the subject was discussed in one chapter (Sci. Am., June 16th, 1917) of a series of Articles on the Submarine problem, which appeared during the early months of our participation in the war.*—EDITOR.]

A Kettleful of Liquid Steel

STEEL is being made in the United States in very large quantities and in as large single furnaces as in any country in the world. While at least 200 tons are made in a single open-hearth furnace, it is seldom that any quantity greater than 100 tons is poured from any one furnace at any one time or into any one ladle or carriage.

Our cover illustration shows the filling of a 100-ton ladle with molten white-hot steel from a 100-ton open-hearth furnace at one of the largest steel plants in eastern Pennsylvania. This furnace is a stationary one, whereas those which contain more than 100 tons are usually capable of being mechanically tilted so that any quantity up to the capacity of the ladle used can be poured.

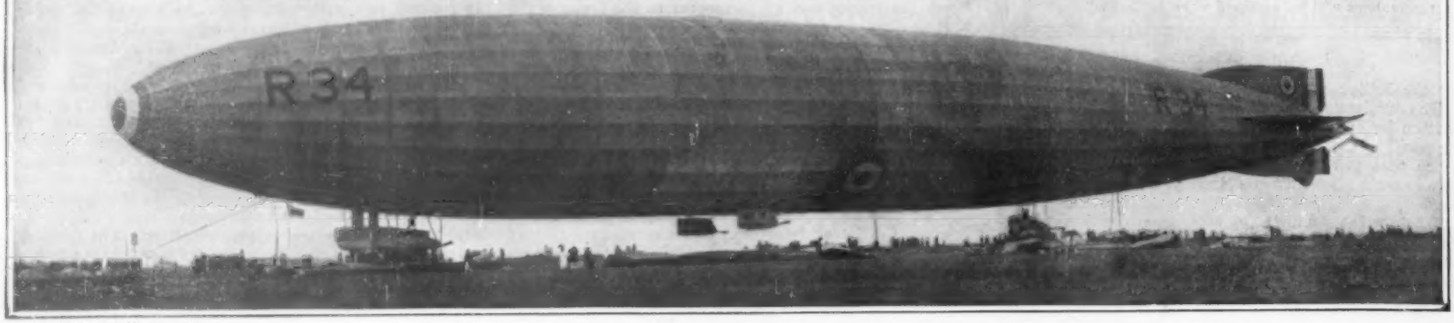
In the present case the white-hot steel is running from a tap-hole in the side of the furnace and the ladle is already practically full—so full that the slag is running over and distributing itself on the ground and the sides of the ladle. This is not unusual—in fact it is customary. All molten steel is covered with a thick slag which is made up of impurities from the pig iron and which acts as a protective covering to the steel. It is always lighter than the steel and floats on top.

A rather unusual feature of this particular case is that the large ladle is standing on a base of brick in the shape of a low pedestal. In most steel mill practice it is usual to have the ladle suspended from a large electric traveling crane from which it hangs directly under the spout of the furnace. All such ladles are of steel plate made in the shape of a mammoth pail. They are then lined with brick and refractory cement and clay and thoroughly dried before the hot metal is allowed to be tapped into them.

The filling of such a very large ladle is a spectacular sight, the overflow of the molten slag and of some steel being not only highly interesting and sometimes dangerous but the emission of sparks is always plentiful.

The Trans-Atlantic Dirigible

Some Impressions of the Dirigible R.34 and of Lighter-than-Air Craft in General



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The R-34 as she appeared on Roosevelt Field, Long Island, just after the completion of her great flight

FOR the third time within two months the Atlantic has been crossed by intrepid airmen. The latest successful flight is that of the huge British dirigible R-34, which left the Royal Naval Air Station at East Fortune, near Edinburgh, at 2 o'clock on the morning of July 2d, and after a more or less adventuresome journey arrived at Roosevelt Field, near Mineola, Long Island, at 8.45 o'clock on the morning of July 6th. The R-34 was commanded by Major G. H. Scott, and the crew comprised 30 officers and men, as well as one stowaway.

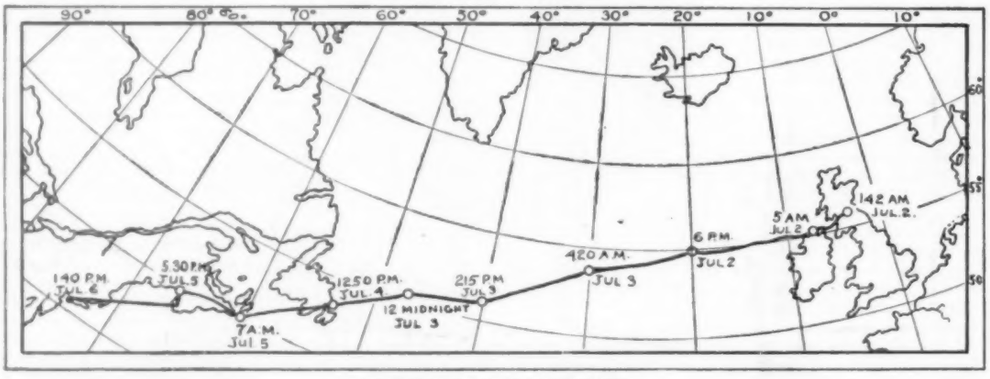
Some Details of the Voyage

The route taken by the R-34 is shown in the accompanying map, which gives the day and hour at various points. Distances covered were as follows: East Fortune to Trinity Bay, Newfoundland, 2,050 sea miles; Trinity Bay, Newfoundland, to Mineola, Long Island, 1,080; or a total of well over 3,100 sea miles. However, because of the adverse winds encountered for the greater part of the journey, it has been estimated that the R-34 actually travelled over 6,300 air miles.

The big British dirigible left Scotland with some 4,900 gallons of gasoline weighing 16 tons, and for this reason she had to fly at a low altitude for the first part of her voyage. Indeed, Major Scott had many anxious moments in passing over the hills of Scotland, which rise to a height of over 3,000 feet, because his altitude was limited to a few thousand feet by the great weight.

The weather was far from ideal. Adverse winds—winds, by the way, that have discouraged most airmen from trying a westward trans-Atlantic flight—reduced the speed of the dirigible by more than half. Fog and low-lying clouds hid the Atlantic waters for the greater part of the time. Between Nova Scotia and Long Island the dirigible encountered violent thunderstorms, which caused no little uneasiness in view of the highly inflammable hydrogen gas in the big bag.

Wireless communication was maintained between the R-34 and the British, Canadian and American radio stations. The wireless range finder served to good stead in aiding the navigation officers. It is reported that the big dirigible was never out of radio touch with the world.



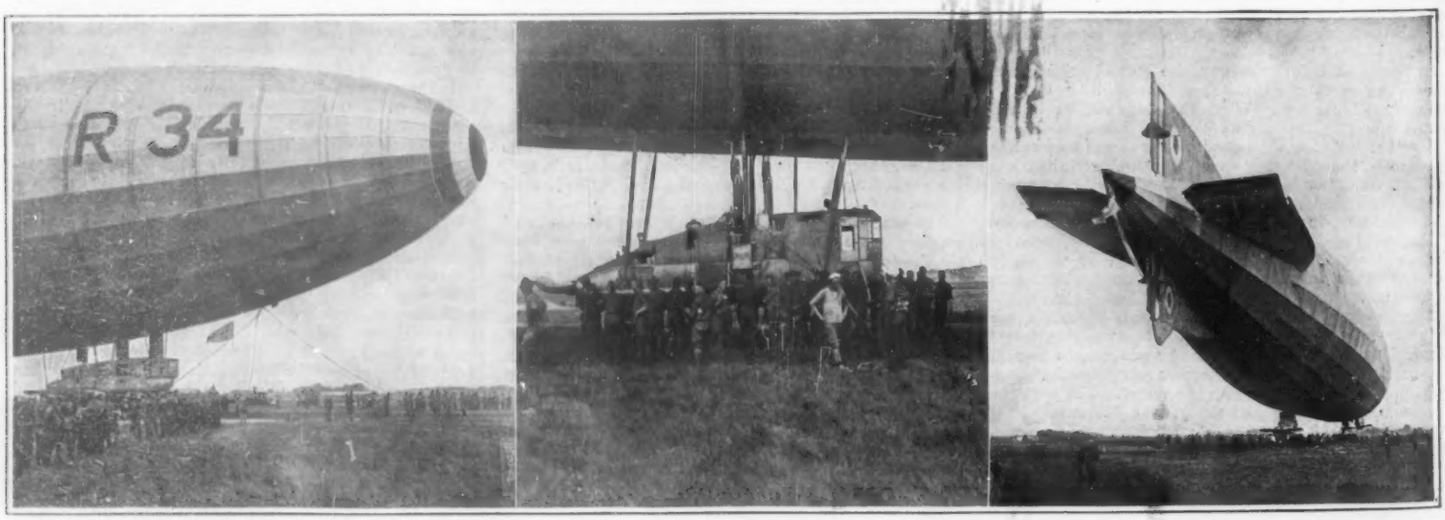
Official chart of the R-34's flight

The time of the R-34 for the trans-Atlantic crossing is slightly greater than the steamship record made by the "Mauretania," which, in September, 1909, made the trip from Queenstown to New York in four days 10 hours and 41 minutes. This is better by approximately two hours than the time of the dirigible, which took four days, 12 hours, and some odd minutes. But the airship covered several hundred miles more distance against head winds, whereas the steamship record was made on a calm sea.

There was a spectacular touch to the last part of the journey. Due to the head winds practically all the way over, the fuel supply of the R-34 began to run short between Nova Scotia and Long Island. In fact, the commander for a time was undecided whether to land at Boston or Chatham, or later, at Montauk Point for refuelling; but as he approached the last-mentioned place a favorable wind brought forth the decision to push on to Mineola if this were at all possible. The engineer, Lieut. John D. Shotter, organized a search party which made a careful inspection of every fuel tank on board. Eighty-one of these tanks, each holding nearly 70 gallons, was searched for gasoline, until enough fuel was secured barely to reach the destination; indeed, it is said that the gasoline still in the tanks on arrival at Mineola would not have lasted much longer than 20 minutes!

A Dirigible Built to Bomb Berlin

The R-34 and her sister dirigible, the R-33, were constructed by the British Government both for naval scouting and for bombing German cities. The R-34 is 672 feet long, and 79 feet in diameter at her greatest girth. From the top of the cigar-shaped bag to the lowest point of her five gondolas she measures about



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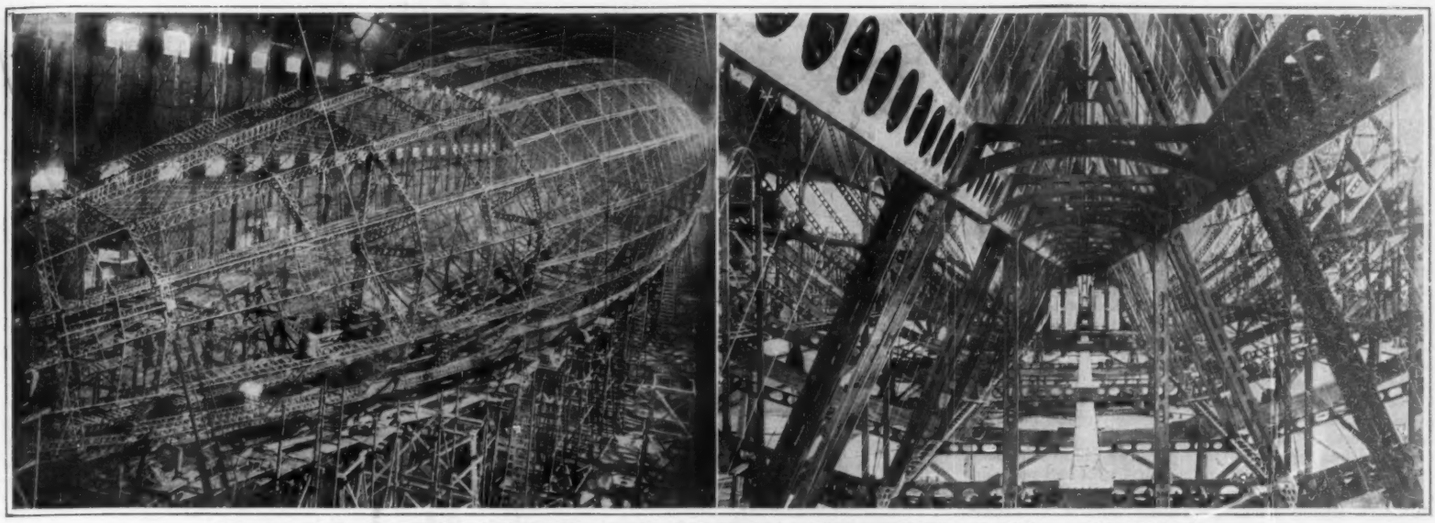
Three striking views of the R-34, showing, respectively, the nose, forward gondola, and the tail



Two views of the R-34 while being built, showing, respectively, the huge framework and "catwalk" or corridor in the bag

90 feet. But it is well to bear in mind at this point that the R-34 is by no means the largest dirigible in the world; the Germans, at this moment, have larger Zeppelins in the air, and the British still larger rigid dirigibles pretty well under way.

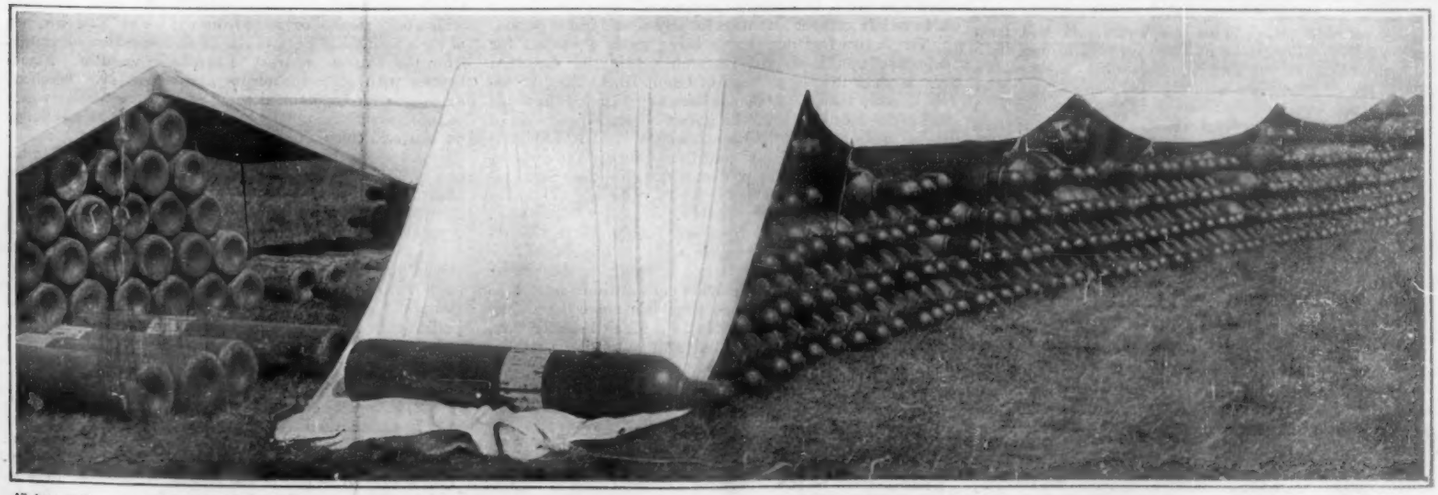
Under the cigar-shaped bag of the R-34 are suspended the four gondolas that carry the crew while on active duty, as well as the five engines. The forward gondola contains the navigating quarters, wireless station, and an engine. The other engines are disposed in the following manner: One engine in each of the gondolas amidship, and two in the gondola aft, a propeller being provided for each engine with the exception of the rear gondola, which has but one propeller for the two engines. The engines are of the Sunbeam Maori type, each developing 250-275 horsepower, and, with a speed of 2,500 revolutions per minute, enabling the airship to make some 70 miles an hour under favorable conditions. However, under ordinary circumstances the engines are not operated at full speed, and the airship cruises along at about 50 miles an hour in fairly still air.

The similarity between the R-34 and the later-day German Zeppelins extends further than the general appearance. In fact, when one comes to examine even the minute features the similarity is striking, although the British have wisely avoided some of the known weaknesses of the German dirigibles. Like the Zeppelin airship, however, the R-34 has a narrow boardwalk extending along the bottom of the big bag, known as the catwalk. The name has been well chosen; for, be it said, one requires the sureness of foot of a cat to walk along the narrow platform, especially with the knowledge that a false step may mean plunging through the thin outer fabric of the bag to the ocean or land below. Still, the catwalk is the accepted means of reaching any part of the airship, from the hammocks and mess quarters in the bag itself to the lookouts on top of the bag and again to any one of the four gondolas.

Two of the floodlights used at Roosevelt Field, and one of the concrete blocks and tackle

The lifting power of the R-34 is obtained from 19 gas bags contained within the duralumin skeleton, which is covered with a taut fabric skin. Each gas bag is placed in a compartment and separated from its neighbors by netting, in order to prevent rubbing; and a valve fastened to each gas bag and controlled by hand wheels or wires from

(Continued on page 66)



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Rows upon rows of hydrogen flasks on the field, ready to be used in re-inflating the gas bags of the R-34

The Service of the Chemist

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Conducted by H. E. HOWE, Chemical Engineer

Purple and Fine Linen

PURPLE has come to signify aristocracy, wealth and power. As is the case with most phrases, it is interesting to trace the one quoted above and see how purple came to have such associations. Price is of course the controlling factor and when the price is such as to limit the use of a material or object to those who are in affluence then these materials and objects readily come to have an idiomatic use. Notwithstanding the high prices of dyes in 1914 and 1919 we must look back much further in history to find a time when dye was really high in price, so high in fact that to "wear the purple" has ever since meant the command of riches.

The ancient purple was the Tyrian purple named after the powerful city of Tyre which like Carthage and Sidon, owed much of its prestige to the purple dye and the cloth colored by it. According to Chas. E. Pellew the Latin records show that no other dye has ever brought so high a price commercially. As the supply diminished the price rose until linen costing $52.00 per pound sold for $652.00 per pound after dyeing. Assuming that 3 per cent of purple on the weight of the goods was required to give a full shade, say on silk, the dye runs into the thousands of dollars per pound.

From records and enormous piles of shells near the ancient cities of the Mediterranean the source of Tyrian purple has been found to be a whitish thick liquid found in a small vein of certain snail-like shell fish. Three varieties may be mentioned—Purpura lapillus, Murex trunculus and Murex brandaris. Only a few drops may be recovered from each fish and 12,000 were required for a quantity of liquid sufficient for accurate analysis of the active principle. As the demand increased the number of fish rapidly decreased as their growth is not rapid. We can easily imagine the great difficulties which had to be overcome in collecting large numbers of fish by crude metheds from more and more inaccessible places.

Finally the art was lost and for 200 years was not revived. In 1685 the "Purple fish" was rediscovered when it was found that an Irish woman living by the sea was using the whitish liquid for making garments for identification after laundering. When this liquid is applied to fibers and then exposed to the sunlight a purple color is developed. If it is not washed with soap a fast crimson is produced. Tyrian purple was evidently of many shades running from a bluish gray to a brownish red through indigo blue, purple and violet. These shades are so varied that we are led to suppose that in time any unusually fine dye was termed purple meaning a quality rather than a definite color. Thus the use of crimson robes by the Catholic clergy of today has come down as a remnant of the practice at the time when the church insisted that its representatives should have the same prerogatives as state rulers and princes.

With such traditions and history it is not strange that a dye chemist should dream of producing synthetically the dye which accounted for so much. The shell fish were identified, 12,000 collected from the old beds where they had again become numerous, and a careful analysis made of the coloring principle in the liquid. It had been assumed that it would be in some form of indigo, both from the color and the way it is developed on fibers, but that it should be a bromine derivative was a surprise for this was the first time bromine had been found to be a component of an animal. Chemically speaking Tyrian purple is 6:6′ dibrom indigo, the molecule containing 12 atoms of carbon, two of bromine, and two each of the CO and NH radicals, arranged so that the bromine and the NH are on the same side.

This could be made in a modern dye plant and sold for $2 or $3 per pound, but there would be no sale. The imperial shades of long ago are too dull and muddy to suit the taste cultivated by modern brilliant, attractive colors. They are no faster to light or washing and are inferior to a near relation, 5:5′ dibrom indigo, now made in our country in quantities that would have astounded the ancients. This modern purple contains exactly the same atoms as its ancient prototype, only the bromine atoms have been transferred, each with a carbon atom, so that they are now on the side of the molecule with the CO radical instead of the NH. And so the most humble wearer of our navy blue is afforded a color in all respects superior to that used to designate the Roman consul and the senators of the Roman state by narrow borders on the toga, and employed by the monks of the Middle Ages in such wonderful work as the "Golden Gospels" in which on purple vellum the written characters are worked in pure gold leaf.

Home Fires

IN discussing smoke abatement problems we frequently overlook the fact that it is not always necessary to have a manufacturing community to get damaging smoke. Some localities derive their smoke from domestic sources up to 60 or 65 per cent of the total and yet the individual units are too small to make practical any of the usual smoke prevention devices. Experience has shown that proper firing will do much toward decreasing smoke, but it is too much to hope that efficient firemen may be developed in any considerable number of homes. For years the use of anthracite in residence districts has prevented smoke, but not only is it out of the question for some cities to have anthracite but the time must come when none of us can have it. We are told that at present there are but 190 tons per capita in sight which fact is further emphasized when we examine a map upon which are plotted our coal areas and see the two small spots where anthracite occurs.

We come then to consider other types of smokeless fuel from which we must leave out natural gas because of its rapidly diminishing supply. In one large city as much as 10 per cent of gas from by-product ovens is being pumped into the natural gas mains to supplement the volume of that gas available. We are left with partially soft coal, lignite, etc., as a possible solution and work is already under way along these lines. Extensive research is involved and the complete utilization of the by-products is essential to the economic success of the plan. It has been found that best results are obtained with coal carbonized at a lower temperature than is used in the manufacture of metallurgical coke and this constitutes problem number one. It means that ovens must be so built as to allow the charge to be stirred to prevent overheating and thin oven walls may be necessary. Either possibility introduces a number of factors.

The use of all the by-products is not completely solved. About half the gas produced is used to do the carbonizing or coking and the remainder is well suited for use in the home or factory. If any considerable number of plants were to be put into commission now the benzene, toluene and pitch would be drugs upon the market, but there is reason to believe that benzene and toluene will find their way into motor fuel, especially when gasoline becomes more scarce and ways found to overcome any objections which have been raised as to their use in internal combustion motors. We can trust research to care for the pitch.

We shall have to learn how to burn coke, but that is not so difficult. Best results in household furnaces seem to be had when most of the air for combustion enters from the top thereby causing the fuel to burn from the top downward. This prevents too high temperatures being reached and the grate bars and furnace linings being burned out. A greater volume of fuel must also be used and care taken in banking the fire with fine coke when it is to be left without attention for any considerable period.

The entire fuel question is being made a subject for scientific and industrial research under the direction of the Fuel Research Board of Great Britain and something more than $500,000 has been set aside for the work in special laboratories. The government Department of Scientific and Industrial Research considers fuel to be one of the questions which should be solved by the government, since it involves problems too broad and fundamental to make it possible for even a research association to undertake the work profitably. In some respects the English problem differs from our fuel problem but research on a very extensive scale is just as important here as there. Much of importance is being done here by government bureaus and private corporations as well as certain universities, but the time has come when fuel research should be undertaken in a much broader way, the present work coördinated and systematic studies initiated and continued. Such work builds for the future as well as being of immediate practical value.

Research and Peace

WE all know that military establishments depend for their success upon more than their own strength and a nation must be in a very favorable condition as regards industrial strength before a war can be initiated as Germany initiated the late war. Industrial strength in turn depends upon the application and both the ability and willingness to use the results of research in pure science. It is admitted that in years gone by Germany excelled in the application of research and so was able to control a number of important materials as an aid in prosecuting war, counting largely upon this condition for early victory.

Much of the story of how our scientists met the situation with wonderful speed has been told, but even yet we fail to realize by what a small margin we escaped. We cannot tell what direction German scheming may now take, but it is fair to suppose that another war cannot be undertaken until new methods and means have been derived. It is the belief of many that our research in chemical warfare should continue in order that our advantage shall not be lost, and surely those infant industries born of war conditions should be made permanent, thereby checkmating the Hun.

Germany formerly dominated the electrical industry in Europe, even controlling the mica from English possessions. The war lost to her this and other essential raw materials and gave rise to the British industry now prepared to displace entirely that of Germany and Austria. Although Britain produced 40 per cent of the tungsten ore before the war, Germany controlled ferrotungsten and metallic tungsten so that at the start of the war she had a great advantage in munitions production. All that was changed during the war. Germany also was in control of zinc, importing quantities of ore from Australia, but now the ore is in other hands and research in zinc is going forward there under competent direction.

This list of advantages permanently lost might be greatly extended but the gains made cannot be kept unless we too learn to create knowledge by pure research and how to apply that knowledge to our industrial problems. We must cultivate science, apply it and train increasing numbers of men in the use and interpretation of scientific data. Just as science made it possible to declare a war so science in right hands can be used to preserve peace.

"Dry" Extracts and Perfumes

THE usefulness of extracts and perfumes for other than their advertised purposes has long been known, but with the advent of new legislation it has been a problem for the chemist to find a way out for the manufacturer. Extracts made in the usual way and then evaporated to dryness after the addition of sugar so that a spoonful of the powder equals a spoonful of the usual fluid, have not found favor with the housewife. Emulsions have been advocated, but almost without exception these separate in a short time. There would seem, however, to be a promising field in this direction for research on the part of some physical chemist.

Where an oil is involved, such as lemon, bakers have found dilution with highly refined vegetable oils satisfactory and get an excellent distribution of the flavor in their product. Vanilla has caused the most concern chiefly because the standard tests involve those for resins which only alcohol extracts from the bean. The presence of such resins has been taken as an indication of vanilla from the bean in contrast to synthetic vanillin. Percolations with glycerine or its derivatives give excellent extracts under controlled conditions, but tests for resins cannot be obtained. Obviously we shall have to change our tests to conform to present conditions.

In work of this type the chemist is rather limited in his choice of solvents for they should have food value, be absorbed by the alimentary tract, and known to have no ill effect upon the human system. Many solvents which suggest themselves are at once ruled out by these specifications. In perfumes the restrictions are not so great, solvents with strong odors being those found most unsuited. Organic research continues to give us new solvents and if we come to the worst we can use undiluted perfumes in small drops in place of the alcohol solution in an atomizer.

A Large Seismological Library

DR. J. C. BRANNER, of Leland Stanford University, has purchased the seismological library of Count F. de Montessus de Ballore, director of the seismological service in Chile, and presented it to Stanford University. This is said to be one of the largest collections of seismological literature in existence, and is accompanied by a manuscript catalogue including some 5,000 titles.

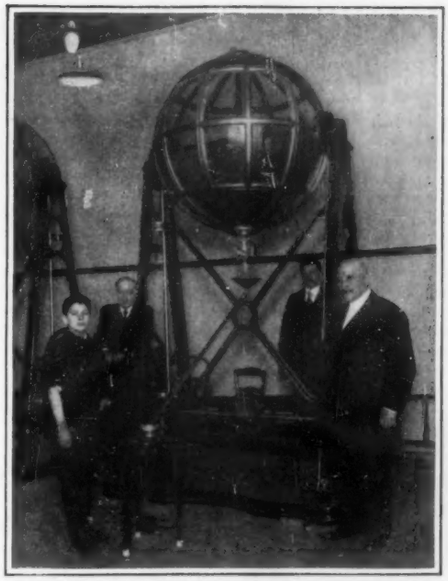
The Biggest Wheel of Fortune

THE City of Paris is to issue a liquidation loan of a billion and a half francs, with certain lottery features. The bonds are to be paid off at par over a period of 60 years, the numbers being drawn each year. In addition, at each drawing there will be a quantity of bonds drawn for bonuses, which will range from $250,000 to $1,000 each. It has accordingly been necessary to devise some means of conducting the drawings which shall be free from every suspicion of fraud or collusion; and the decision was made to construct a huge wheel of fortune, large enough to hold 3,125,000 tiny cartridges, each containing a slip of paper with the duplicate number of one of the bonds.

It was also necessary to have the machine so constructed that when once the numbers had been introduced, it should be impossible for anybody to tamper with them. The result of these demands is the huge orange-shaped hollow sphere illustrated herewith. The framework is of steel, filled in with plates of half-inch glass so that the contents can be easily seen.

This monster sphere, which is 20 feet high by 18 feet broad and weighs 6½ tons, is supported 6 feet from the ground by two iron stanchions which hold the axletree of the sphere at each side. At the top of the sphere is a small aperture or hole, no greater in circumference than a man's thumb, and communicating by a short tube with the interior. Into this interior the cartridges containing the numbers of the bonds are shot automatically by means of electricity. When they are all in, a little steel trap door or breech plug, like the shutter of a camera, and moving almost as rapidly as a snap-shot apparatus, is closed by a spring and an outer brass shutter is clasped to and locked with three patent keys, specially made in America, and sent for the purpose to France. The aperture, thus locked, is sealed with white tape on which is set the great red seals of the City.

When a drawing takes place, the huge globe, or sphere, is set revolving by means of small wheels, fixed at each end of the axletree, moved by electric power. This mixes up the numbers. When the globe comes to a standstill, the aperture, instead of being on top, is below, perpendicular to the floor. The seals are then broken, the outer shutter is unlocked and opened, and an electric "extractor" is slid into a groove which automatically locks the extractor to the aperture. The electric current is then connected, a button is pressed, the inner steel shutter flies rapidly on one side, and one of the little brass cartridges falls through a tube into the extractor or magazine. A second electric button is then pressed and the tiny cartridge falls through the bottom of the extractor into a long glass funnel, onto a table where a thick glass bowl has been set to receive it. It is opened and its number recorded with due formality and precautions, and its lucky holder thereby assured of the prize which is coming to him.



This wheel of fortune will decide each year which of 3,125,000 Parisian bonds shall carry a big bonus

When the Small Family Goes Bicycling

AN ingenious Englishman has a youngster who is very fond of taking "go goes"—the baby word for outing. How to take the baby on an outing when the Englishman and his wife are enthusiastic cyclists was the problem to be overcome by the father of the child. Being an amateur mechanic, however, he patterned from a piece of sheet iron the simple body shown in the accompanying illustrations. An iron bar supports the body of the improvised go-cart from the fork over the seat of the cycle, and a similar bar extended from the axle of the rear wheel gives the contrivance stability. To prevent the baby from falling out, a strong strap is provided; and to prevent the baby from toppling over when the bicycle is at a standstill, an adjustable support reaching to the ground, is used.

The leaves of the Madras water lilies will readily support the weight of a child

Baron Rayleigh

BARON RAYLEIGH, who died on the evening of June 30th, was generally recognized as the foremost physicist of Great Britain, if not of the world. Born in 1842, he graduated from Trinity College, Cambridge, in 1865. Thereafter he devoted himself exclusively to researches in the field of physics, and with such effect that in 1879 he succeeded Clerk Maxwell as Cavendish Professor of Experimental Physics in Cambridge. This place he held until he took in 1887 the post of Professor of Natural Philosophy at the Royal Institution of Great Britain, which he resigned in 1905, the year after he received the Nobel Prize in Physics.

Baron Rayleigh first achieved note through his papers in mathematical physics written under his patronymic of J. W. Strutt. His apparatus was plain and often crude in its externals, but with the essentials designed with the utmost care. He possessed a rare combination of mathematical ability and experimental skill. Doubtless his most celebrated single achievement was the discovery in 1894 of argon, one of the inert gases in the atmosphere, and the first known of these. But his less spectacular work was of far greater importance. A catalog of this work would look like the index to a text book in advanced physics; but of all the subjects with which he dealt, perhaps those in which he achieved the most lasting results were chemical physics, the theory of gases and the flow of liquids, photography and color vision as well as more general work in optics, the theory of wave motions, electric and magnetic problems, and hydrodynamics.

Waterproof Glues in Automobile Manufacture

SOME of the new waterproof glues developed primarily for aircraft purposes during the war offer the possibility of overcoming a difficulty that has proved very annoying, both to the automobile owner and to the manufacturer, wherever linoleum is used on the running boards or as a covering for the floor of the car. Ordinary glues which are soluble in water are not very effective in cementing linoleum, and most automobile owners have soon discovered that the glue disintegrates and the linoleum comes loose after the car has been washed a few times.

Casein glues are admirably adapted to this purpose, and if the quality is right and they are properly applied the linoleum should give no trouble during the life of the car. Casein glues are exceedingly resistant to the action of water and retain a very high percentage of their original strength, even after long immersion under water. They are comparatively inexpensive, and the materials from which they are made are readily available in the market. They are applied cold and will set without the application of heat.

Information on casein glues and their application may be obtained from the Forest Products Laboratory of the U. S. Forest Service, at Madison, Wis.

Lily Leaves as Rafts

DOWN in the Madras district of India there are lilies that grow leaves of phenomenal size. Indeed, these leaves are several feet in diameter and have turned-up edges to form a shallow bowl which floats on the water. The buoyancy of these leaves is such that they will readily carry the weight of a small child, as shown in the accompanying illustration. This variety of lily is known as the *Victoria Regia*.

Father, mother and baby on the road with their bicycles

Improvised go-cart which is fastened to the rear part of the bicycle

A Millionth of an Inch

How the Wave-Length of Light Is Used to Detect Errors of This Infinitesimal Amount

IN an earlier issue we described the invention of the American precision block by Major W. E. Hoke of St. Louis; and we pointed out that this gage was so very accurate that the only feasible measure for its errors was the wave-length of light. Now as we suggested in our previous discussion, the interferometer measures in terms of light waves; but it is a laboratory instrument and not a tool. The general principle on which it works, however, is promising; so the Bureau of Standards sought to develop this principle in a somewhat different direction, to afford a means for checking the Hoke gage that should be comparable in speed and cost with the process of manufacture.

In this effort the Bureau was successful; and that it was not working on virgin ground should not detract in any way from the credit due. As a matter of fact, it is 20 years since Prof. Albert A. Michelson of Chicago first laid down the principles involved. At that time there was no possibility of doing work which called for such testing, so little attention was paid Michelson's paper. Again in 1910-11, the very firm which is now making the Hoke gage canvassed Michelson's findings; and again the times were not ripe and the thing had to be dropped. But now Major Hoke has attained the degree of workmanship which compels commercial utilization of the light wave.

The principle involved is known as interference. Light is a wave motion. The length of a wave is but a few millionths of an inch, and the amplitude is correspondingly minute; but none the less, these waves behave in a thoroughly wave-like manner. In particular, if the crests of two waves are superposed, there is a double effect; while if a crest of one wave falls with a trough of another, there is a killing-off or "interference."

Under ordinary circumstances interference of light waves does not occur. This is simply because under ordinary circumstances light waves are not piled up on one another. But sometimes this piling up occurs; and then, just so sure as the piled-up waves are in the same phase they reinforce one another, while if they are in opposite phases they interfere.

Suppose we have a very thin space between perfectly smooth glass plates. A ray of light R_1 passing through the upper plate reaches the under surface (see Fig. 2) at A, where it splits, part passing directly on through the space as the ray R_3, while part is reflected as the ray R_2. It may not be wholly superfluous to assure the reader that such reflection, from the inner side of the glass surface, really occurs. The ray R_2 proceeds, and falls on the upper face of the second plate at B. Here it in turn is partly reflected as the ray R_4 and partly transmitted through the glass as a ray in which we have no further interest. The reflected ray R_4 passes back through the space until it meets the lower surface of the upper plate a second time at C. Here once more a split occurs, into the transmitted ray R_5 and a reflected ray which we need not follow.

Light from the original ray R_1 passes upward from the points A and C. The first reflected ray R_2 we speak of as primary; the ray R_4 we call secondary. Now at the point C there falls a ray S_1, parallel with R_1; and its primary reflected part goes upward along the identical path traversed by R_4. Along this and every other path we have then not a simple ray directed upward, but rather a compound ray composed of a primary (as S_3) and a secondary (as R_4).

It is now that the question of phase arises. If R_4 and S_3 are in the same phase the combined ray R_4+S_3 will be strong. If they are in opposite phase, so that the crest of one falls upon the trough of the other, there will be interference—they cancel one another out and leave a weak ray or perhaps none at all. When the space between two glass plates is of uniform thickness, there will be precisely the same degree of interference throughout, and nothing startling will happen. But consider the case where that thickness varies. It is here possible for the two waves that join at A to be in phase, so that their resultant is strong, while the waves that join at C are in opposite phase, setting up interference. If we then look down through the upper plate we will see alternate bands of light and dark hue—light where there is reinforcement, dark where there is interference.

If the light falls upon the plates almost vertically, the path of the rays across the space from one plate to another is approximately equal, in any vicinity, to the distance between the plates in that vicinity. The secondary ray at any point C will then have travelled further than the primary by a distance approximately equal to twice the width of the space at that point.

Here we are confronted by temptation into error. It seems that the secondary ray through B will reach C in phase with the primary that comes to C direct, when the distance ABC is an exact multiple of the wave-length—that is, when the distance between the plates is an exact number of half wave-lengths. But in fact we get dark bands under these circumstances, with light bands between them at the points where the distance is ¼, ¾, 5/4, or some other odd number of quarter-lengths, making the additional journey of the secondary ray an odd number of half-lengths. Puzzling as this is, we can nevertheless interpret it correctly.

The reflection that takes place at A is identical with that which takes place at C; whatever happens in the one point must be duplicated in the other. But at B conditions are different. At A and C light is reflected as it passes from a denser medium upon the surface of a rarer one—or, if we regard the reflection strictly as a phenomenon of the glass surface, we may describe it as internal. At B the reflection takes place on passage from a rarer medium to the surface of a denser one—in terms of the glass surface again, reflection is external.

The treatment to which light is subjected during reflection is not the same under these differing conditions. Suppose a man, running full tilt, were to smash head-on into a brick wall. He is thrown back—reflected, if you please. But this does not describe fully what happens to him, for there are two alternatives. He may be hurled back in the direction whence he came without being turned around, so that until he checks his recoil he is moving backward, with his right and left hands occupying the same relative positions as during his onslaught upon the wall; or he may be turned around by his impact, and thrown from the wall face foremost, with his right and left transposed from their positions before the shock.

Now for no reason that can be made very clear, when light is reflected internally by a glass-air surface, it is not turned around; when reflected externally, on passing through the air to fall upon the glass, it is turned around. Figure 3 shows, side by side for more effective comparison, a wave train R being reflected internally and another train S, originally in phase with R, being reflected externally. For simplicity in drawing, the rays are assumed to have struck vertically. Each ray, after

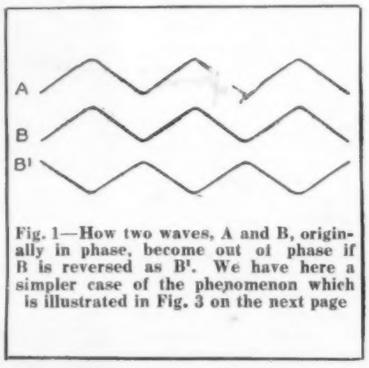
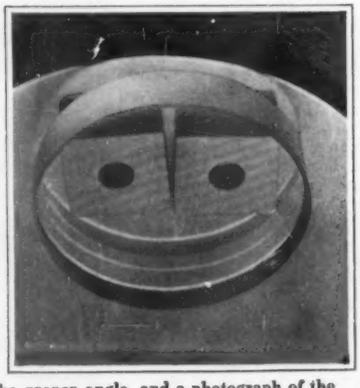


Fig. 1—How two waves, A and B, originally in phase, become out of phase if B is reversed as B'. We have here a simpler case of the phenomenon which is illustrated in Fig. 3 on the next page



The apparatus for throwing a beam of monochromatic light at the proper angle, and a photograph of the interference fringes thus obtained. These are difficult to catch well in the camera because of their hue; visually however they are very distinct

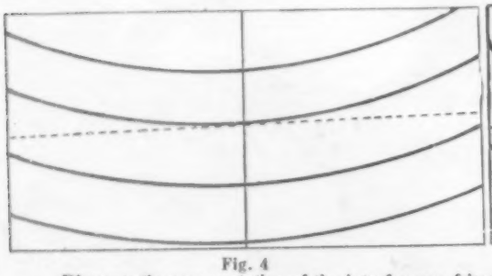


Fig. 4

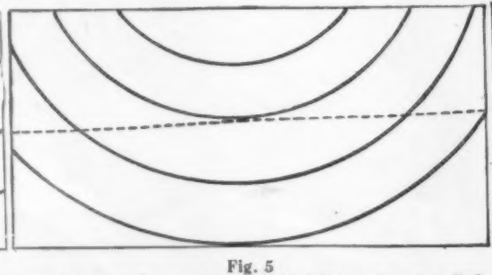


Fig. 5

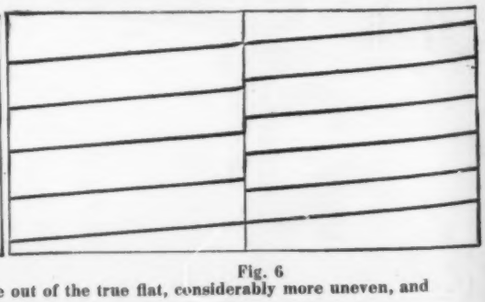


Fig. 6

Diagramatic representation of the interference fringes which, from left to right, tell that the surface is a little out of the true flat, considerably more uneven, and that the tops of the two blocks are not parallel

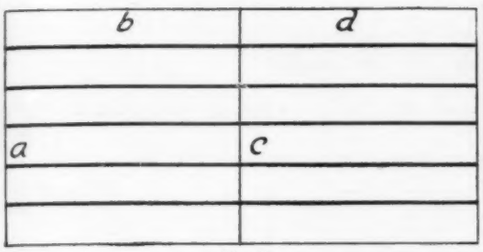


Fig. 7

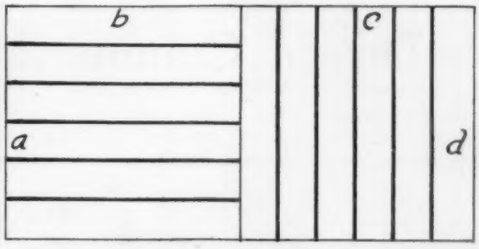


Fig. 8

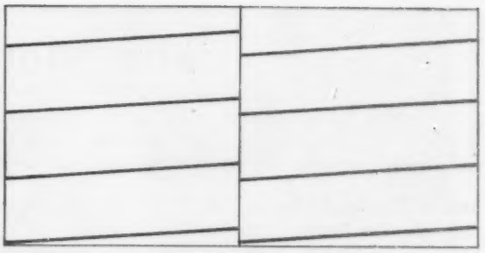


Fig. 9

What the fringes look like when the tops of the two blocks are parallel to each other and to their bases; what happens when this test appears to be met, but we turn one block around to discover that the tops were only parallel to each other and not to the bases; and the appearance which tells us that the blocks are perfect but of different heights

eflection, executes the unfinished portion of the wave upon which it was engaged before, as indicated by the dotted lines. But R is not reversed and S is, so after finishing out these waves, R is at a crest and S at a trough (or vice versa). The rays are now in opposite phases, or one of them has gained (or lost) a half wave-length, as compared with the other. The same thing could be shown, but less convincingly so far as the part played by the reflection is concerned, by taking two parallel wave trains and turning one of them over; it would then be out of phase, where originally it was in phase, with the other (see Fig. 1).

This is what happens at A, B and C. The primary ray through C is reflected internally at C, the secondary ray through C is reflected externally at B. One of them is set back half a wave-length as compared with the other. To bring them out even at A, the excess distance traveled by the secondary ray must be ½ or 3/2 or some other *odd* number of half-lengths; the distance from plate to plate must be an *odd* number of quarter-lengths.

Then if two blocks, of which the lower need not be glass at all, are so well made as to leave a very thin film of air between them, we can pass light down through the upper one, and on observing the reflection we will see interference bands. Where we get a light band, the surfaces are ¼, ¾, 5/4, etc., wave-lengths apart; where we get a dark band, the distance is ½, 3/2, 5/2, etc., wave-lengths.

If we know nothing about the contour of either of the surfaces save that each is almost plane, that is as far as we can go. But suppose we are able to say that one of the surfaces is plane within a much smaller margin of error than the .00002 inch or thereabouts represented by a single light wave? In that event, our interference fringes give us a contour map of the other surface. The dark bands are the contour lines; the contour interval is one-half wave-length, or in round numbers, with a proper choice of light, 1/100,000 of an inch.

That is the way the Hoke gage-block is measured. An optical flat—a piece of glass with surfaces so true that no error of refraction or reflection can be detected—is a first necessity. This is not cheap or easy to make; but during the process of grinding, light can be sent through it to check its accuracy by actual performance, and any high or low spots thus located and measured. This makes the manufacture of optical flats possible; and given three of these and a Hoke block, the rest is easy.

The first question is whether the upper face of the block is plane. To answer this we use one block and one flat. We do not try for contact between these all over; we simply bring the glass and the steel together along one edge of the steel. If the block is flat we can do this; having done it, if the block is flat the wedge of air between the glass and the steel is a true one, running off uniformly, and the fringes are straight. If we tilt the far side of the glass away from the steel, the contour of the wedge is sharper, and the contour lines run closer together. If we swing the far edge of the glass closer and closer down upon the steel, the fringes spread farther and farther apart. Wherever they fall, whatever their thickness and spacing, if they are straight the surface of the steel is true in the direction in which they run. It is, however, necessary to turn the block about and test it in the other direction, since otherwise a cylindrical effect might elude us. If such a curvature were marked, the irregular spacing of the straight interference fringes would give it away; but if it were slight this might not be noticeable. Hence the necessity of applying the test in both directions, so that if the face tested is not a true plane, we are certain of getting some curved contour lines, somewhere, to show this.

This method not only tells us when the face tested is out of true, but it tells us by how much. The points along a given contour line are all at the same elevation, if we may be permitted to use this word a bit loosely. If the blocks were true, points at the same elevation would lie in a straight line. Therefore, if we visualize a straight line drawn tangent to any contour line, and follow this line to the edge of the block, we can estimate the error quite accurately in tenths of a contour interval —which means in millionths of an inch. Thus, in the group of idealized contour maps which we show, Fig. 4 represents two blocks which, over their combined surface, show a discrepancy of about eight millionths; Fig. 5 shows a very badly made pair, with errors of two whole wave-lengths, or 20 millionths of an inch.

After testing one face and finding it plane, we test the other face. If it is plane, we next want to know whether the two are parallel. For this purpose we require two blocks, to be tested together; and we require a second optical flat. Upon this the two steel blocks are wrung side by side, so as to stand fair and true upon a common base. Then if each block is self-parallel, the upper faces of the two must be mutually parallel. To find whether they are so, we place the glass along the long edge of the double block—the front edge as they are pictured. Then if the two top surfaces are parallel, we have a single uniform wedge of air across both blocks, and the contour lines will run clear across as in Fig. 7; but if the surfaces are not parallel, they form two separate wedges, for which the pitch and consequently the spacing of the contour lines is different, as in Fig. 6.

This is not the end of the parallelism test, however. The upper surfaces may be parallel to one another, and still not parallel to their respective bottoms. They may run off at a common angle, in other words. So we turn one of the blocks around, as indicated by the lettering in Fig. 8. If the blocks are trully self-parallel, this does not change the fringes at all; but if the tops of both are inclined, after the change one of the slopes runs across the other instead of with it as before. This makes the two air wedges stand at right angles to one another, and we get the contour map of Fig. 8.

Finally, suppose we have two blocks each of which has been shown to have two plane and parallel surfaces. The question now is, are they the same thickness? Of course they are very close, but are they identical? To answer this, we wring them upon the common base again, and apply the glass to the long front edge. If they are the same height, we get contact all along this edge, forming a single true wedge as shown already in Fig. 7. But if they are not the same height, we get exact contact only along the front edge of the higher one, and with the lower one we form a truncated wedge, with a blunt edge instead of a sharp one. Corresponding faces of these wedges will be parallel to each other, because both blocks are self-parallel; but at all points one wedge will be a shade thicker than the other. The fringes will then run at the same angle, and be the same distance apart, on both blocks; but they will be displaced at the junction of the blocks, and by an amount which measures the difference in height of the two pieces, as far as the number of millionth-inches is concerned. But it will not be obvious, for instance, whether the two blocks are .2, or 1.2, or 2.2, etc., half-wave-lengths apart.

This little detail is immediately disposed of by tilting the glass so that it has contact with the front, right-hand corners of both blocks. This turns the wedges about so that they run diagonally; and, if the difference in height is more than a single half-wave-length, one or more of the contour lines will run off the front of the lower block. Thus, in Fig. 9, this final adjustment has been made, and it is seen that the right-hand block is only two millionths lower than the left—not 12 or 22 millionths.

There are a lot of interesting points involved, aside from the main argument. One has to do with the accuracy of the glass flats. We need two of these to carry out the tests; but if we had only two, and were led to suspect that one of them had lost its accuracy, we could not tell which was wrong without resort to the interferometer; and we do not have interferometers in our factories. But if we have three flats, we can apply the first to the second and to the third, and the second to the third, observing the interference fringes each time; and this tells us which one of the three is inaccurate.

(Continued on page 72)

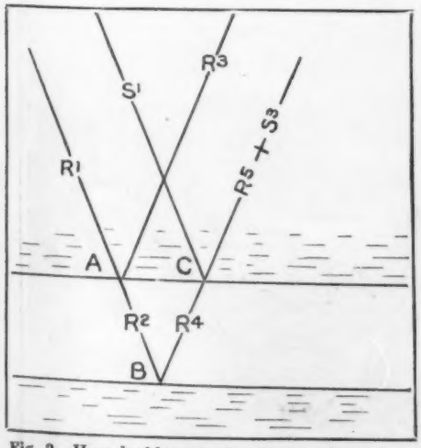
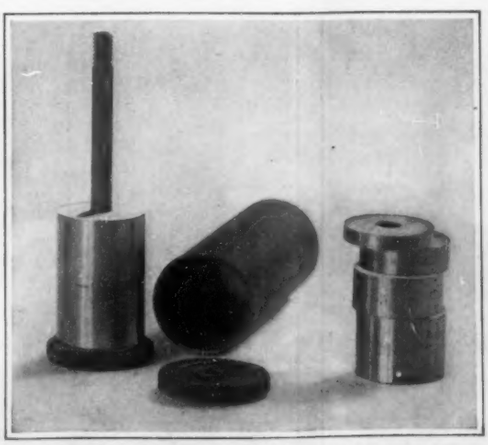


Fig. 2—How double reflection from surfaces close together leads to interference



A handy pocket set of wringing gage blocks for the general mechanic, soon to be on the market

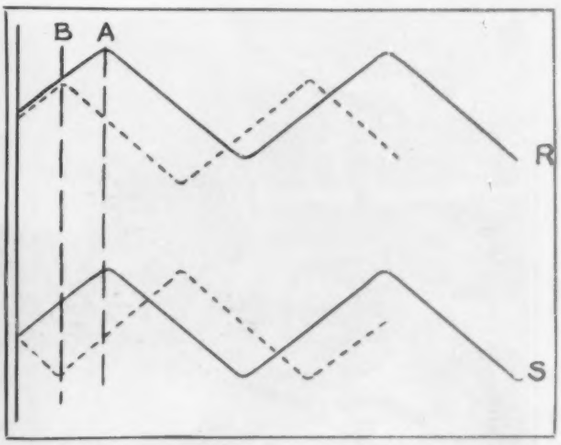


Fig. 3—How a wave reflected externally (below) is reversed and set back a wave-length, compared with a wave reflected internally (above)

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGÉ, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

Interesting Special Duties for the Truck

SPECIAL duty trucks are more or less of an old story; we are inclined to think that we have seen them for every sort of special duty that could possibly be devised. That such a very broad impression may be erroneous, however, is indicated by at least one of the trucks illustrated herewith.

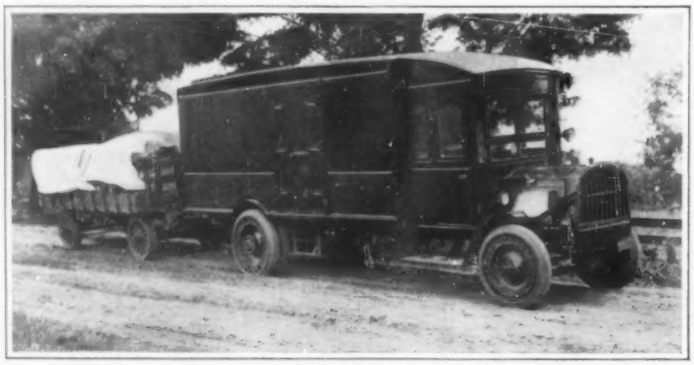
The stake-driver truck helping to move the circus to the scene of the next stand

The stake-driver truck for circus use is certainly a new one. Of course, we all know that the circus, in its travels from town to town, comes in, first and last, for a tremendous lot of stake-driving. Then, too, most of us know that of late years the circus has been pretty thoroughly motorized. But most of us will be prepared to receive this latest innovation as a novelty.

The stake driver, attached to the rear of the truck, is a miniature pile-driver, with hammer and derrick for driving and pulling stakes. The power for driving the stakes is supplied by a small horizontal gas-engine, distinct from the power plant of the truck. This, of course, is an economy; there is no sense in using the big, powerful truck engine for this comparatively light work; it would be altogether too much like driving carpet tacks with a sledge-hammer. The truck, in addition to carrying the stake-driving mechanism, is used for the heaviest kind of tractive work. Our cut shows it, in the daily trek to the "next town," hauling two good husky trailers; and it will be noted that it carries a ring in front for pulling loads on reverse.

Another interesting development of the special duty truck is the refrigerator truck for hauling meat. The one we illustrate was got up to meet a very real local need. It takes two and a half days to make a carload shipment of fresh meat from Detroit to Toledo by rail. With the truck shown, a Detroit packing house makes the trip with nine tons of meat in six hours. It will be realized that the economy is not merely an operating one, but consists equally in getting the meat to its destination in better condition.

The body of this refrigerator truck is designed much like the standard refrigerator car. The ice tanks are filled from the top. To make the service pay a maximum return, it carries general merchandise on the return trip to Detroit.



The refrigerator truck that delivers Detroit meat to Toledo in six hours

Using a motor sweeper for sanding slippery streets in wet weather

Motor Sand-Spreading Machine

THE accompanying illustration shows a novel motor sweeper, equipped with sand spreading attachments. The Street Cleaning Department of San Francisco developed two uses for this machine; one as the regular sweeping machine, and the other when equipped with an added attachment for spreading sand on smooth street pavements.

It is explained that in rainy weather the motor sweeping machine cannot be used to advantage for sweeping, but by this added attachment, it becomes a sand spreading machine, which distributes coarse clean sand evenly over the pavement in a light or heavy coating as desired. It is used on the occasion of public parades, and on wet and very foggy days, when the streets are slippery and dangerous to traffic, thus preventing many accidents which might happen from horses slipping and falling, and from the skidding of autos. This sanding attachment is also the only successful remedy for removing the oil spilled on pavements by automobiles, tank wagons, etc. To make the change from the sweeping machine to the sander and vice versa takes less than one hour.

It is held that this sanding attachment can easily be incorporated with a separate chassis, making a machine which will be in great demand, as there are many cities where similar conditions as to slippery streets and oily pavements exist; and this trouble from oil is constantly increasing owing to the great growth of the automobile industry. With this new attachment placed on a lighter chassis, the machine can also be used for distributing seed on farming lands.

Special Truck Body for Handling Brick

THE large percentage of waste brick caused by chipping or breaking during transportation has cut down the profits to the manufacturer to a very great extent, and the special truck body for handling this material will interest all

(Continued on page 74)

Special truck body for hauling brick, in the act of dumping

The position from which the brick truck drops its load without damage

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"OUR records show that a Goodyear Solid Tire on Bus Number 205 delivered 100,123 miles of continuous service. We have never heard of another mark as high as this. It is certainly creditable, since our service conditions thoroughly test truck tire stamina. Two more of our Goodyear Solid Tires may reach this figure—have traveled in excess of 99,000 miles each, thus far."—George A. Green, Chief Engineer, The Fifth Avenue Coach Company, New York City.

PROBABLY the longest mileage attained to date by a rubber tire has been delivered by the Goodyear Solid Tire described in the statement quoted above.

Yet observe that two other Goodyear Solid Tires in the same service are challenging this score, having recently passed the 99,000-mile mark.

And then add the fact that a group of 43 Goodyear Solid Tires thus far has rolled up scores ranging from 25,000 to 80,000 miles for The Fifth Avenue Coach Company—demonstrating uniform ability to reach uncommon mileage figures.

All 46 have had to withstand the strains resulting from about 1,000 starts and stops made per day by each Fifth Avenue Bus.

The first-mentioned tire remained in this work close to three years, and yet at the end of the time its tread rubber was $1\frac{3}{16}$ inches thick.

These facts and figures supplied by The Fifth Avenue Coach Company do more than contribute to the great mass of proof that bespeaks the powerful qualities of Goodyear Truck Tires.

They also focus important attention on the Goodyear methods of tire inspection and care adopted by this user and employed by hundreds of Goodyear Truck Tire Service Stations spread over the continent.

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The Current Supplement

THE great Naval Stores industry of the southern States has been experiencing a new lease on life during recent years and we are all interested in the reason why. This reason is rooted in the intelligent interest taken by the University of North Carolina and by the U. S. Forest Service in the particular problem; and the story of the struggle to introduce common-sense and economical methods for cropping resin and turpentine is interestingly told in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT No. 2272, for July 19, 1919, under the caption *"Cupping" versus "Boxing."* Investigations into the circumstances of a tragedy, a theft, or an accident, often need a carefully precise drawing or map showing with unassailable veracity the arrangement and disposition of objects at the scene of the occurrence. Several devices have been offered for the benefit of the photographer who would accomplish this from photographs of the spot, but the simplest and most precise method has come from across the ocean and is described for us with great clearness and detail under the caption, *A New Method in Photogrammetry.* The generality of the solution will appeal at once to all who desire to or must work with an ordinary camera. In *Flotation for the Practical Mill Man* will be found a valuable general discussion of the methods and processes comprised under "flotation" and the manner in which they are to be handled. The interesting discussion on flax *The Strongest and Most Durable Fiber* is here concluded; as is also the interesting account of those experiments on *Acquired Radioactivity.* A shorter new article tells of French experiments with *A New Apparatus for Studying Fogs*

The Trans-Atlantic Dirigible

(Continued from page 59)

the navigating quarters up forward permits gas to be released from any bag at will, in order to regulate the buoyancy and trim of the huge craft.

Hydrogen, which is used in the R-34, is highly inflammable and explosive when mixed with air; so much so, in fact, that extreme precautions must be taken against the slightest spark. The crew wear rubber-soled shoes or moccasins while on board, and flames of any sort are not allowed. Cooking and heating must be done electrically. Still more, the huge mass of duralumin framing must be carefully connected together and electrically tested, so that there will be no difference of potential between sections of the framing, which might result in a discharge or spark when used as the "capacity ground" of the wireless station.

The sleeping arrangements consist of a hammock for each of the men off watch, suspended from the main ridge girder of the triangular internal keel which runs from end to end of the ship. In this keel are situated the 81 gasoline tanks, each of 70 gallons capacity; also, there are the living quarters of the men and the officers, and storage space for lubricating oil, water ballast, food, and drinking water for the crew. The latter is quite a considerable item, as is apparent from this table of weights:

	Gallons	Pounds	Tons
Gasoline	4,900	35,300	15.8
Oil		2,070	.9
Water			3.0
Crew and baggage			4.0
Spares		550	.2
Drinking water		800	.42
Total			24.32

The gondolas, which contain the business end of the ship, are enclosed and provided with suitable windows. The crew divide their time between the gondolas and the living accommodations in the big bag; and all in all their life is not such a hard one. There is plenty of room for exercising; hot food can be obtained without

(Continued on page 68)

LEGAL NOTICES

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SCIENTIFIC AMERICAN

contains Patent Office Notes. Decisions of interest to inventors—and particulars of recently patented inventions.

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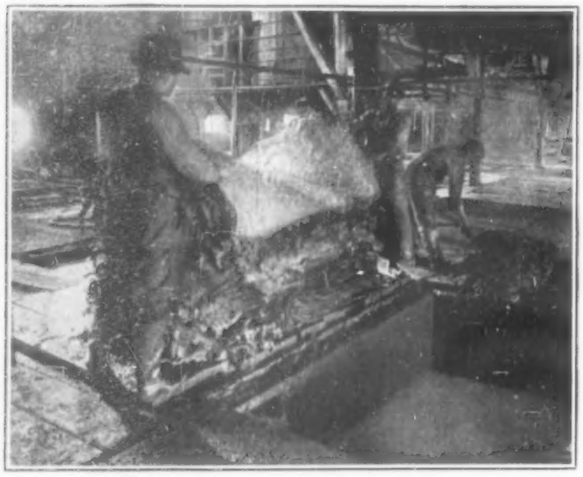

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Hartford, Connecticut

Chicago Branch 1837 So. LaSalle St.

New York Office 2 Rector St.

The Trans-Atlantic Dirigible

(Continued from page 66)

trouble; sleeping accommodations are good; and, most surprising of all, no doubt, there is very little noise or vibration except when one is directly over a power unit. There is a total absence of wind, and, except in the early hours of dawn, greater warmth than in the surrounding atmosphere.

As a battle-cruiser of the skies the R-34 carried two four-inch guns, several machine guns, four bombs weighing about 580 pounds each and capable of destruction over an area of 40,000 square feet, and eight small bombs, weighing about 250 pounds each. However, as soon as the Germans decided to sign the peace pact the R-34 was remodeled as a non-fighting craft and her cruising capacity greatly increased by the addition of six fuel tanks, bringing the fuel capacity up to 4,900 gallons.

How the Engines Fared During the Long Trip

According to Lieut. Shotter, engineer officer of the R-34, the engines performed remarkably well. In fact, in going over the engines at Mineola, preparatory to starting on the return voyage, it was found that aside from very minor repairs, such as the cleaning of carburetors and magnetos and the replacement of 60 out of 120 spark plugs, the power plant was practically ready for further service. Of course, the engines had to be tuned up, and the propellers had to be cleaned of the coating of engine oil which accumulated on the blades in the course of the flight, and revarnished.

The crew of the R-34 did not take unnecessary chances with their engines. As proof of this assertion there was a large stock of spare parts aboard for every emergency. Furthermore, there was sufficient reserve power to enable the engineer to use only part of his total power for most of the journey, thus giving the engines the minimum wear and tear. In this connection it is said that with one engine running the R-34 makes 20 knots in still air, while 30 knots can be attained with three engines running. So it is evident that total engine failure is quite a remote consideration on a dirigible of this type, and in her trying flight the R-34 did not have a single engine failure.

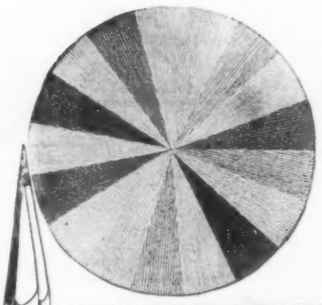
The real troubles of the crew of the R-34, strangely enough, began when the good ship touched the ground at Roosevelt Field, near Mineola. For, like all dirigibles, the R-34 is really safest when in the air, except where proper housing facilities are at hand. In anticipation of the arrival of the big British dirigible our Army and Navy prepared the big aviation field. Hundreds of steel bottles of hydrogen gas, numerous tank cars containing gasoline, searchlights and floodlights, ballast bags, huge concrete blocks with steel tackles firmly imbedded in them, and a powerful wireless telegraph and telephone station were assembled at Roosevelt Field, together with a trained personnel of several hundred Army and Navy men. The preparations were carried out on a stupendous scale, confirming once more the heavy expenses and trouble involved in the operation of a giant rigid dirigible.

Pygmies and the Helpless Giant

An airplane is safe once it reaches the ground. It may be left out in the open with little fear of damage, provided the winds blowing at the time are somewhat short of a gale. Not so with the dirigible, however, especially the huge rigid dirigible. On the ground, unprotected by windshields or hangars, the dirigible requires constant care if the slightest winds are stirring.

The crew of the R-34, no doubt, were far more anxious about their work while resting at Roosevelt Field than when under way. During her stay on Long Island the R-34 was subjected to rather harsh treatment at the hands of the elements. Strong and puffy winds, blowing first from one direction and then from a totally different direction, gave much trouble and anxiety

(Continued on page 70)



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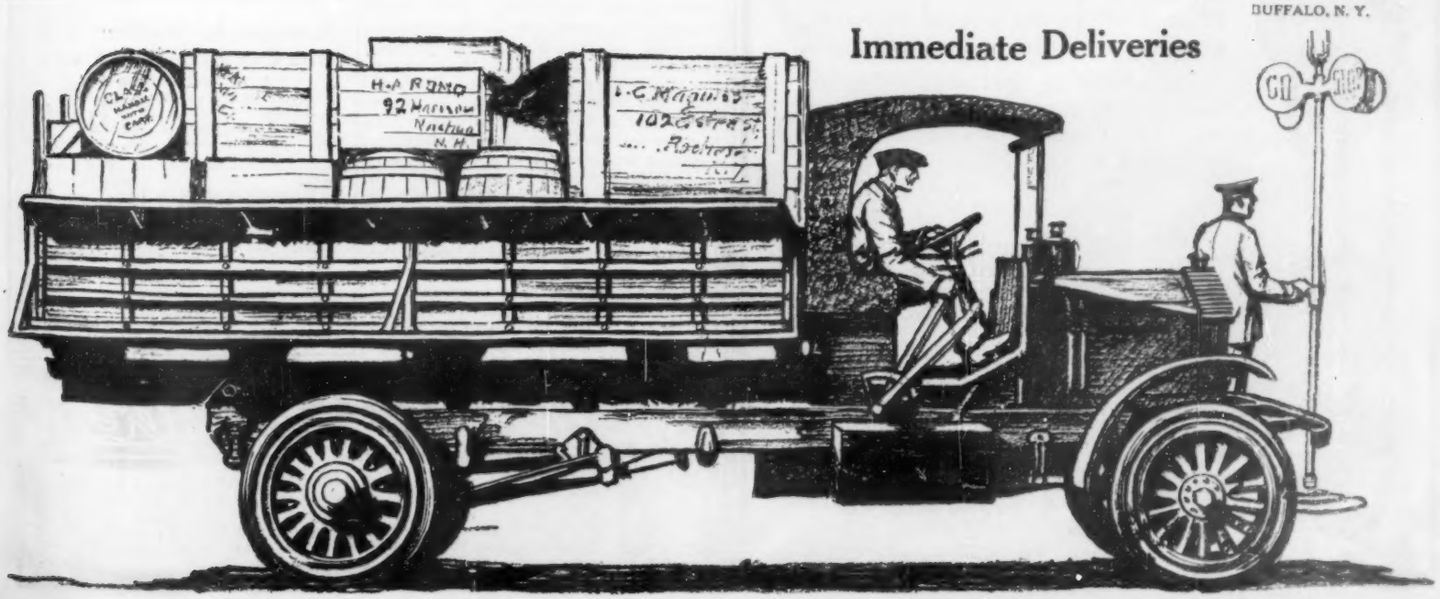

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The Grus Oiler is put on in a few minutes' time, with a screwdriver and small pocket wrench. No holes to cut—nothing to alter. Simply place it on the spring, draw out to proper width and tighten set screws. Then draw down to proper height and tighten bolt. It is self-feeding and requires no attention but to put in oil every thirty days. It helps to make shock absorbers unnecessary, because your springs have a chance to do their proper work. And it saves you the expense and bother of having springs taken apart and graphited.

See what enthusiastic users say about the Grus Oiler, then see what a remarkably liberal free trial offer we make.

Through Mr. J. W. Porch, of this city I learned of your spring oiler, and would like to get right sent on trial, if you still make that offer. As Mr. Porch has found them so satisfactory, feel confident I will. Miss M. A. Dresser, 5105 Prytania St., New Orleans, La.

Set Screw Adjusts to Width of Spring
Oil Reservoir
Catch Lug For Adjusting to Depth of Spring
Felt Packing Feeds Oil to Spring
Catch Lug For Adjusting to Depth of Spring

Inclosed find $9 for your oilers, which I must confess are the best yet. My Willys 6 rides like a Pullman since I have put on your invention. Please permit me to thank you for your generous offer proving that what you say of this wonderful oiler is facts or return the goods free of all costs. R. C. Rice, R. F. D. No. 2, Box 17, Auburn, Wash.

I would not be without them on the car for twice their price. Wishing you the best of success. S. E. Washburn, City Engr., City of Montgomery, Alabama.

Inclosed find my check for $9.00 in payment of enclosed bill. If you at any time have any other auto accessories that are as successful as these oilers, you may send them to me without question. They are all you claim for them and then some. I have heretofore tried two other oilers that do not compare with these for efficiency. Carroll S. Bucher, 201 Merchants Exchange Bldg., San Francisco.

The oilers are entirely satisfactory. Herewith my check to cover. S. V. Walton, Yuba City, Cal.

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We will send you, *at our own risk and expenses*, a set of Grus Oilers, charges prepaid. Put them on. Keep them twenty days. Then if you are not *absolutely satisfied* that they put an end to squeaking and breaking—that you are riding easier—and that there is less strain on your car and tires—if you are not *sure* of all this, send them back. But if you keep them, send us the purchase price—$11.25 for a set of ten (for platform or three-quarter elliptic springs); $9.00 for a set of eight (for cantilever or semielliptic springs); or $5.00 for a Ford set of four.

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Write for particulars

The Yale & Towne Mfg. Co.

9 East 40th Street New York City

The Trans-Atlantic Dirigible

(Continued from page 68)

to the British crew and officials, as well as the American hosts and the Army and Navy mooring crews.

Resting in the middle of the wide expanse comprising Roosevelt Field, the R-34 looked every foot of her 672 feet of length. Her silvery bag could be seen for miles about, reflecting the light of the sun in many different hues because of the slight discoloration here and there of the aluminum-"doped" fabric covering. Because of the highly inflammable nature of the 2,000,000 cubic feet of hydrogen gas, guards were thrown out all about the dirigible for a distance of about a quarter of a mile, and only privileged persons permitted to enter the huge circle in the center of which lay the R-34 straining at cables which moored her to Long Island soil, with the help of several hundred husky doughboys or "gobs."

A dirigible of the type and size of this big Britisher must be kept nose on to the wind, to avoid serious bending strains, if not the blowing away of the bag. Even with a changeable wind of some 25 miles an hour the R-34 was no easy ship to handle. Hundreds of men were handling ropes leading to the nose of the bag, while large groups of other men raised the forward and aft gondolas whenever called upon to do so. By keeping the dirigible on the ground it was possible to make the necessary repairs, and at nightfall the dirigible was allowed to ride out several hundred feet above the field while securely fastened to the steel cables terminating in steel anchors imbedded in the huge concrete blocks.

During the writer's visit to the R-34 he witnessed the rather exasperating experience of two men attempting to varnish the propellers on the gondolas located amidship. In order to reach up to the huge propellers, the men were supported on top of one of the fire trucks used at the Roosevelt Field. A dozen or so husky doughboys served as motive power in hauling the fire truck to a position under the propeller. However, no sooner were the men at work on a propeller when the dirigible would start swinging off to one side or the other. Surely, in the course of painting one propeller these good men must have traveled several miles!

In order to keep the dirigible head-on to the wind, a young Naval lieutenant was placed under the nose, with megaphone in hand. Watching the constant shifting of the wind by the British Jack flying above him, the lieutenant issued orders to the crews on the ropes and beside the gondolas, through a big megaphone. Half way down the great length of the gas bag another officer took up the order and relayed it through his megaphone to the crew beside the aft gondola. At each order to shift, the crews beside the gondolas raised the dirigible off her bumping bags and carried her about while the crews on the ropes pulled in the desired direction. Not only this, but occasionally water ballast had to be released, as well as gas, in order to "trim" the craft for the ever-changing conditions of wind and weather.

With all these men constantly engaged in shifting the huge bag in a wind that is barely felt on the ground, and with thousands of gas flasks and gasoline tanks and ballast bags and other supplies lying about in profusion, one begins to appreciate how helpless the dirigible is as compared with the present airplane. However, it is true that the R-34 was practically out of her

(Continued on page 72)

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This is the only complete book on the "why" and "how" of Welding with the Oxy-Acetylene Flame, and from its pages one can gain information, so that he can weld anything that comes along.

No one can afford to be without this concise book, as it first explains the apparatus to be used, and then covers in detail the actual welding of all automobile parts. The welding of aluminum, cast iron, steel, copper, brass and malleable iron are clearly explained, as well as the proper way to burn the carbon out of the combustion head of the motor

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233 Broadway, Woolworth Bldg., New York

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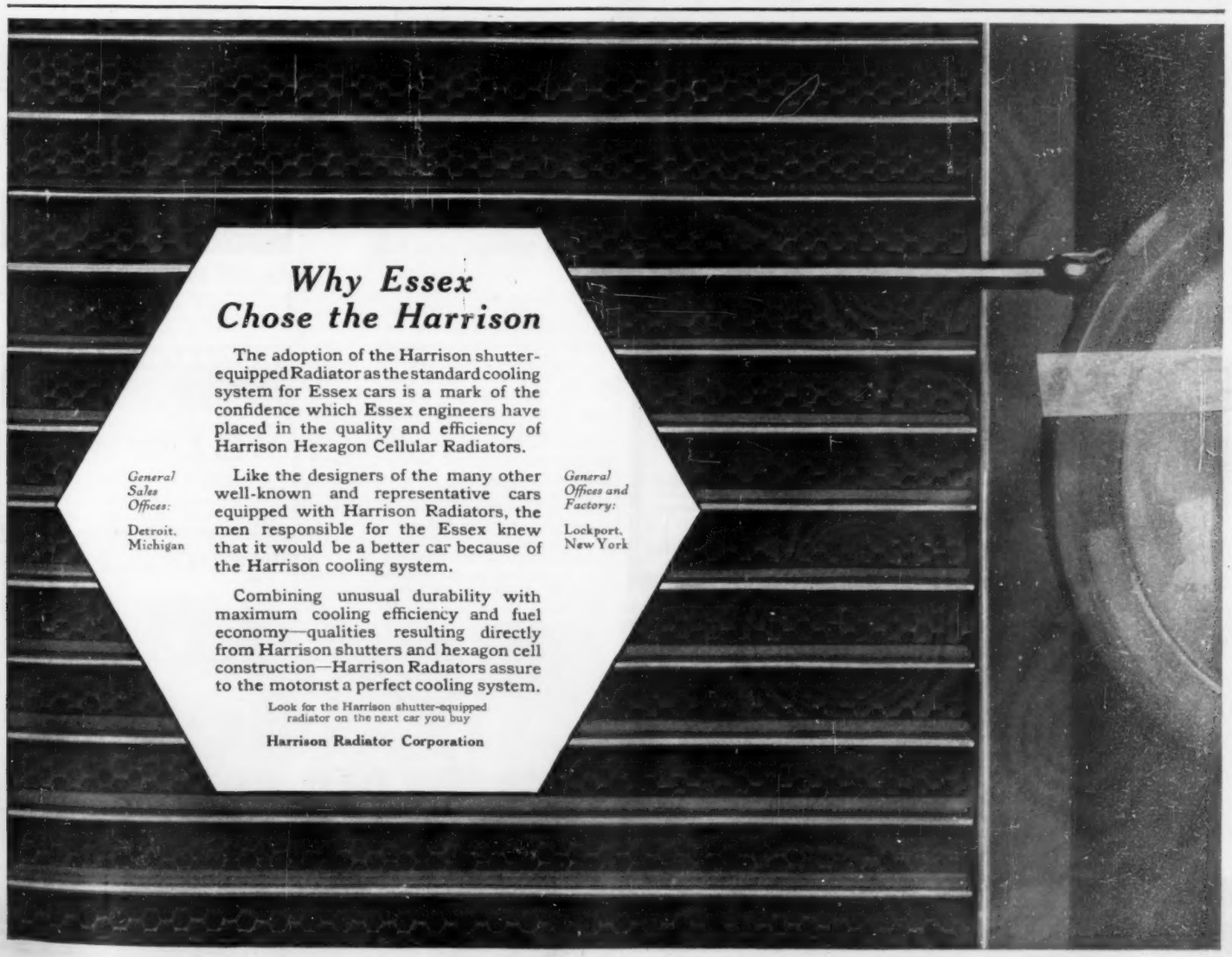
HARRISON *Shutter-Controlled Hexagon* Radiators



Why Essex Chose the Harrison

The adoption of the Harrison shutter-equipped Radiator as the standard cooling system for Essex cars is a mark of the confidence which Essex engineers have placed in the quality and efficiency of Harrison Hexagon Cellular Radiators.

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Detroit, Michigan

Like the designers of the many other well-known and representative cars equipped with Harrison Radiators, the men responsible for the Essex knew that it would be a better car because of the Harrison cooling system.

General Offices and Factory:
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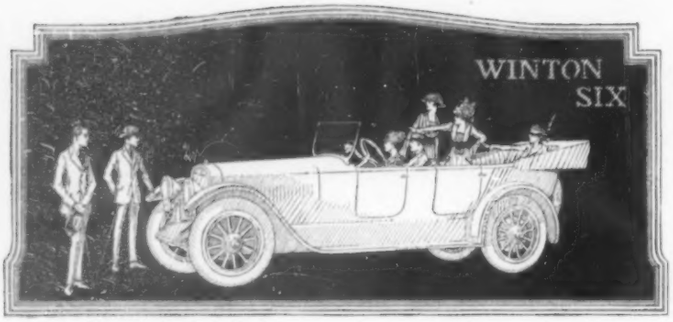
Combining unusual durability with maximum cooling efficiency and fuel economy—qualities resulting directly from Harrison shutters and hexagon cell construction—Harrison Radiators assure to the motorist a perfect cooling system.

Look for the Harrison shutter-equipped radiator on the next car you buy

Harrison Radiator Corporation



Coming August 1

a most surprising new-style private car

RAPID getaway; wonderful pulling power at low engine speed; a range of 33 to 70 H. P. that masters the miles and breezes over hills; flexibility to meet every driving need; as steady as a clock, without chatter or side-sway; a charming bevel-edge body, picturing the freshest and most advanced motor car beauty; lounging-room comfort; in brief, a car that makes life more worth living because it multiplies your happiness—all this you will find in the very newest Winton Six. Ready August 1st. May we send you literature?

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Winton Oil Engines for yacht and motor ships, and Winton gasoline-electric light and power Generating Sets are manufactured by the Winton Company in a separate, splendidly equipped plant, devoted exclusively to these two products. Write us your needs.

The Trans-Atlantic Dirigible

(Continued from page 70)

element while resting in an open field on Long Island, and that in her base at East Fortune, Scotland, her handling is a matter of routine and practically free from all danger.

With a View to the Future

The Atlantic has now been spanned by a lighter-than-air craft as well as by airplane, and a new era has been entered so far as aviation is concerned. It is significant that the British, in commenting on their great achievement, made it clear that the R-34 was almost obsolete today as a first-class dirigible, and that larger dirigibles were rapidly nearing completion. They pointed out that a reasonable increase in the dimensions of the dirigible increased its lifting power and speed enormously, so that in the very near future we could reasonably look forward to dirigibles measuring 1,000 feet or more in length, and carrying 200 tons of cargo.

As for the landing problem of huge dirigibles this is but a matter of being properly prepared. Our arrangements at Roosevelt Field, it is evident, were improvised. Our Army and Navy did not have sufficient notice to prepare suitable housing facilities; but now that long-distance travel by dirigible seems to be so close at hand, we can rest assured that suitable mooring and housing facilities will soon be provided at various points along our coasts.

And in this connection it may be that suitable mooring towers, such as have been described and illustrated in these columns many times before, may prove quite suitable for mooring dirigibles out in the open, making huge sheds necessary only for building and repairing the aerial greyhounds.

At any rate, the dirigible has proved its long-distance flight qualities in a big and successful way. Trans-Atlantic flight service is rapidly approaching realization, although much remains to be done by way of making the craft more sturdy, more powerful, and better carriers of men and goods.

A Millionth of an Inch

(Continued from page 63)

The argument is one already familiar to those who have to use straight edges and other precision instruments.

Another important consideration is that of temperature. We have perhaps described the tests in such a way as to lead it to be supposed that they are easy to apply, at any time and in any place, without any particular precautions. Such is far from the case. Steel expands and contracts. The little gage blocks get larger and smaller as the thermometer goes up and down. Even the man who uses the blocks as a master gage for setting calipers has to remember this, and make his settings at the temperature for which the gages are guaranteed to be accurate—for he knows that at other temperatures they are not accurate. How much more carefully, then, must the gage-maker himself take account of expansion and contraction!

The coefficient of expansion of the steel used in making the Hoke gage is such that the little block will increase or decrease its thickness by the amount corresponding to a single interference fringe each time the temperature changes by one-seventh of a degree Fahrenheit. So delicate is this matter that in the course of a test great care has to be exercised not to touch the blocks with the fingers. Indeed, if a glass flat be put over a *pair* of blocks, and *one* of the pair be grasped between two fingers, it expands so rapidly that one can actually see it grow—the fringes spread out or crowd together about as fast as the eye can comfortably follow them. Of course this little experiment requires a pair of blocks in order to give a fixed magnitude to which the growing block can be referred.

SOMETIMES WE SEE A PERSON WHO DOESN'T USE A
WHITING-ADAMS
TRADE VULCAN MARK RUBBER CEMENTED
SHAVING BRUSH

Very full of smooth best quality bristles or badger hair. They make shaving a pleasure. Treated with U. S. Government's process of preventing infection. Anthrax cannot come from them.

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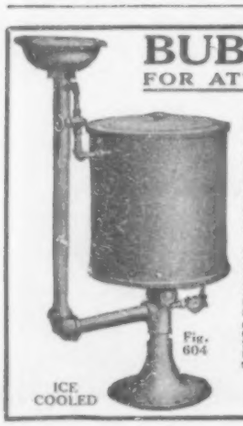

Unequalled Keith Bubbler Unless otherwise specified.

This cut shows our No. 604—75 lbs. of ice—cork insulation—15 1-2 coils of 1-2 in. brass tubing No. 20 Gauge. Thorough workmanship—selected materials. Tested and adopted by those whose judgment is unquestioned.

Many *types* and sizes. May have coil on bottom as well as on sides. Tasty—convenient—and *efficient*. Very attractive appearance.

Olive brown baked enamel finish — Pure white vitreous cast iron enameled bowl. Fittings — nickel-plated. Wastes above or below the floor.

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Metal Equipment For Shop And Factory

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America's Largest Lathe Builders

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Friction Disk Drill
FOR LIGHT WORK

Has These Great Advantages.

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Owners of the world's largest Asbestos Mines

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STEEL STAMPS LETTERS & FIGURES
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MASON'S NEW PAT. WHIP HOIST

for Outrigger hoists. Faster than Elevators, and hoist direct from teams. Saves handling at less expense.

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LIGHT AUTOMOBILE STAMPINGS
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WELL DRILLING PAYS WELL

Own a machine of your own. Cash or easy terms. Many styles and sizes for all purposes

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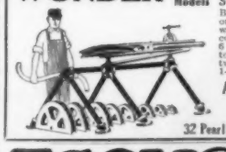
WONDER 9 Models PIPE, TUBING AND SOLID BAR BENDERS



Bend all sizes of standard or double thick steel, wrought iron, brass and copper pipe from 1-8 in. to 6 ins.; tubing from 1-2 in. to 7 ins.; round square and twisted solid stock from 1-4 in. to 3 ins.

American Pipe Bending Machine Co.
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insure maximum safety and minimum cost in safeguarding electrical circuits against the fire and accident hazards of overload and short circuits. An inexpensive "Drop Out" Renewal Link restores a blown Economy Fuse to its original efficiency. The Economy is a pioneer renewable fuse. As compared with the use of one-time fuses, it cuts annual fuse maintenance costs approximately 80 per cent.

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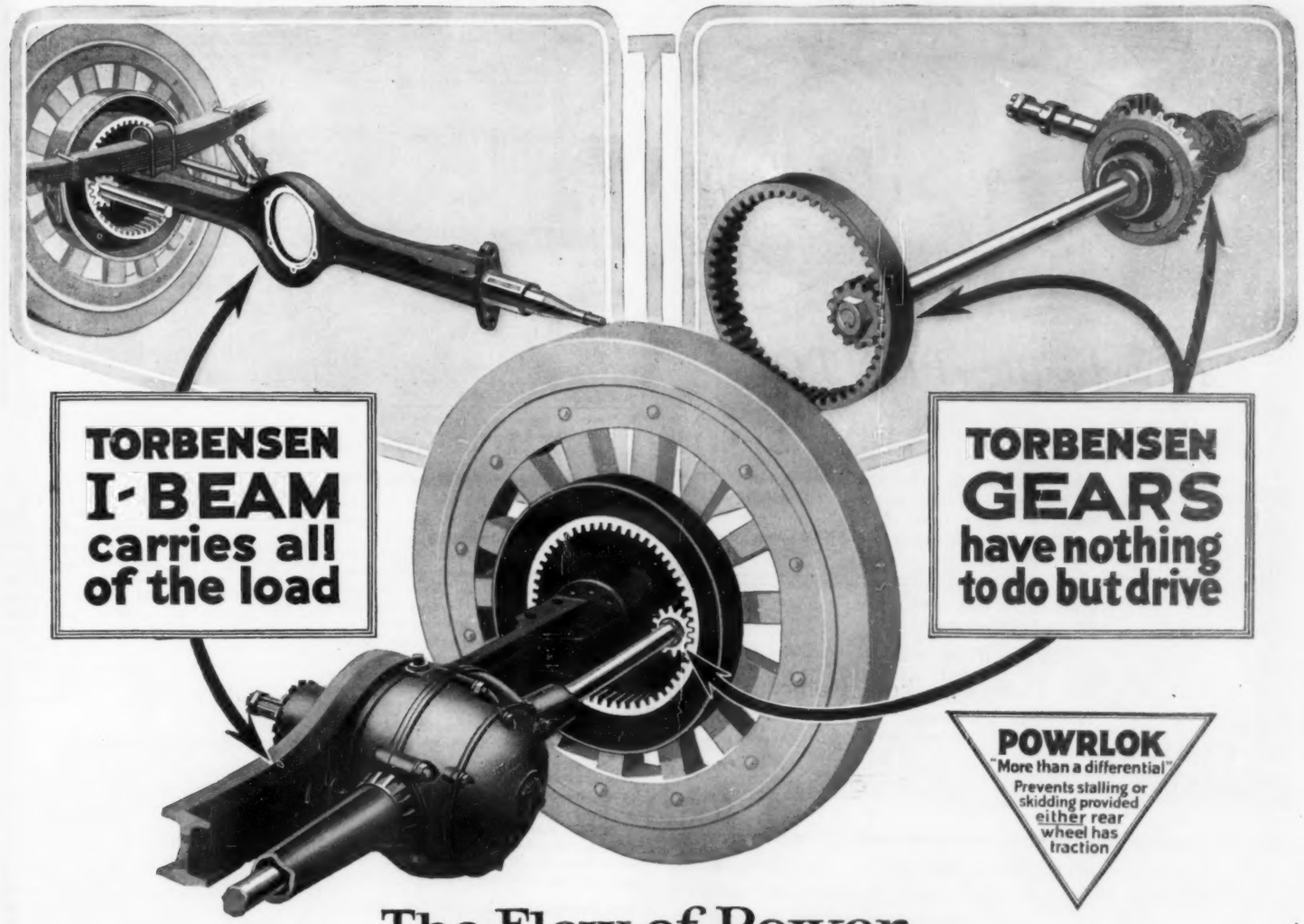
Sole manufacturers of "ARKLESS"—the Non-Renewable Fuse with the 100% Guaranteed Indicator

Economy Fuses are also made in Canada at Montreal



The Flow of Power

BECAUSE it has nothing to do but drive, the entire driving mechanism works as smoothly and steadily as a finely balanced, stationary engine with a fixed load. This even flow of power results in a big saving in gas and oil, and both engine and driving gears last long and maintain high efficiency with very little attention and few repairs.

Because the principal speed reduction is made through the internal gears at the wheels, small bevel gears can be employed to transmit the power at right angles, with a small differential, which allows for unusual road clearance.

Greater leverage resulting from driving at the wheel near the rim reduces torque and makes it possible to employ a small jack shaft and small jack shaft bearings. This reduction of bearing surface causes a corresponding reduction of friction in bearings with a resultant saving of power.

The Torbensen practice of carrying the entire load on a powerful, forged I-Beam Axle, makes it possible to do away with many cumbersome parts, reducing the weight by one-half. This reduction of unsprung weight means longer life for tires.

Torbensen Drive saves on gas and oil, on repairs and on tires — and it stays on the job.

The Torbensen Axle Company also produces front axles for trucks, made in accordance with Torbensen standards of materials and design.

THE TORBENSEN AXLE COMPANY, CLEVELAND, OHIO

Makers of Front and Rear Truck Axles

TORBENSEN INTERNAL GEAR TRUCK DRIVE

LARGEST BUILDER IN THE WORLD OF REAR AXLES FOR MOTOR TRUCKS

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—our newest top material—absolutely the highest quality, rubber-surfaced top material that can be produced.

Pure, live rubber and a super-strong fabric base makes Pontop supreme. Guaranteed one year from date of shipment against leaking, cracking, peeling, blistering and blooming.

On just complaints we will replace the material, its cost of transportation and the labor of replacement.

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Tycos RECORDING PYROMETER

Tycos Pyrometers are a necessity in every industry involving the application of high temperatures.

Just write for our catalogue describing these efficient *Tycos* aids.

Taylor Instrument Companies
ROCHESTER, N. Y. 67

Record of Performance of NC-4 in Crossing the Atlantic (see page 55)

	Elapsd Time H.&M.	Dist. N. Miles	Speed Gd	Speed Air	Gasoline Consumed	Gasoline Per Hr.	Oil Per N. M	Oil Consumed	Oil Per Hr.	Dist. Miles	Wght. Pounds
Rockaway to Off Cape Cod	4-51	284	59	68	420	84	1.22	40	8	284	25,298
Chatham to Halifax	4 03	355	88	68	450	100	1.46	31.5	7	355	25,113
Halifax To Trepassey	6-23	474	75	69	572	88	1.28	40	6 6	474	24,810
Trepassey To Horta	15-13	1,206	79	68	1,340	80	1.28	110	6 4	1,206	28,249
Horta To Ponta Delgada	1-45	153	88	70	135	84	1.20	10.5	6	153	20,891
Ponta Delgada To Lisbon	9-43	786	80	65	860	86	1.42	5 5	5.5	786	26,216
Lisbon To Mondego	1-52	134	74	..	.....	..	....	...	...	134	.....
Mondego To Ferrol	3 09	237	75	65	1,020	85	1.40	7.2	6 0	237	26,026
Ferrol To Plymouth	6-59	487	70	..	.....	..	....	...	...	487	.....
Total	53-58	4,116	76	68	4,797	85.5	1.32	359	6 6	4,117	

NOTE—The average horse power per engine in air was 270 horse-power: the average speed of engines was 1,475 revolutions per minute: the weight of NC-4 at full load was 14 tons, and the weight of gas and oil was a little over 5 tons.

Special Truck Body for Handling Brick

(Continued from page 64)

dealers. The body fits all make of trucks, and can be dumped in such a way as to leave its load of brick on end, neatly piled, all without jar which might chip or break the brick. This method saves time and money over the hand stacking and takes a smaller space than when dumped.

Where a number of bodies are in use, one can be loaded and ready for the truck as soon as it returns from delivering a load. It takes less than five minutes to disengage the empty body and take up the loaded body. The empty body is unloaded on to a small truck which runs into the storage building on rails. Here the body is loaded and shoved out again ready for the return of the motor truck. This two-body detachable system allows the truck to run almost continuously. A truck making four loads a day under the old system should make from ten to fifteen loads by means of this detachable method.

New Process for Cleaning Locomotives

THE cost of wiping locomotives with oil and waste under present conditions is very high, and there are now few roads on which the engines are thoroughly wiped at the end of each trip. Furthermore, cleaning by hand forces the oil and dirt into cracks and fillets and leaves a coating of oil to which dust adheres very quickly. A method of cleaning locomotives which reduces the cost of the work and also eliminates the objectionable features mentioned is now being installed on railroads by a cleaning process, made in Chicago. By this process a mixture of air, oil and water is sprayed onto the locomotive at a uniform pressure of about 90 pounds. The nozzle discharges the mixture in a spray which is directed against the surface to be cleaned at an angle of about 45 degrees from a distance of about 18 inches.

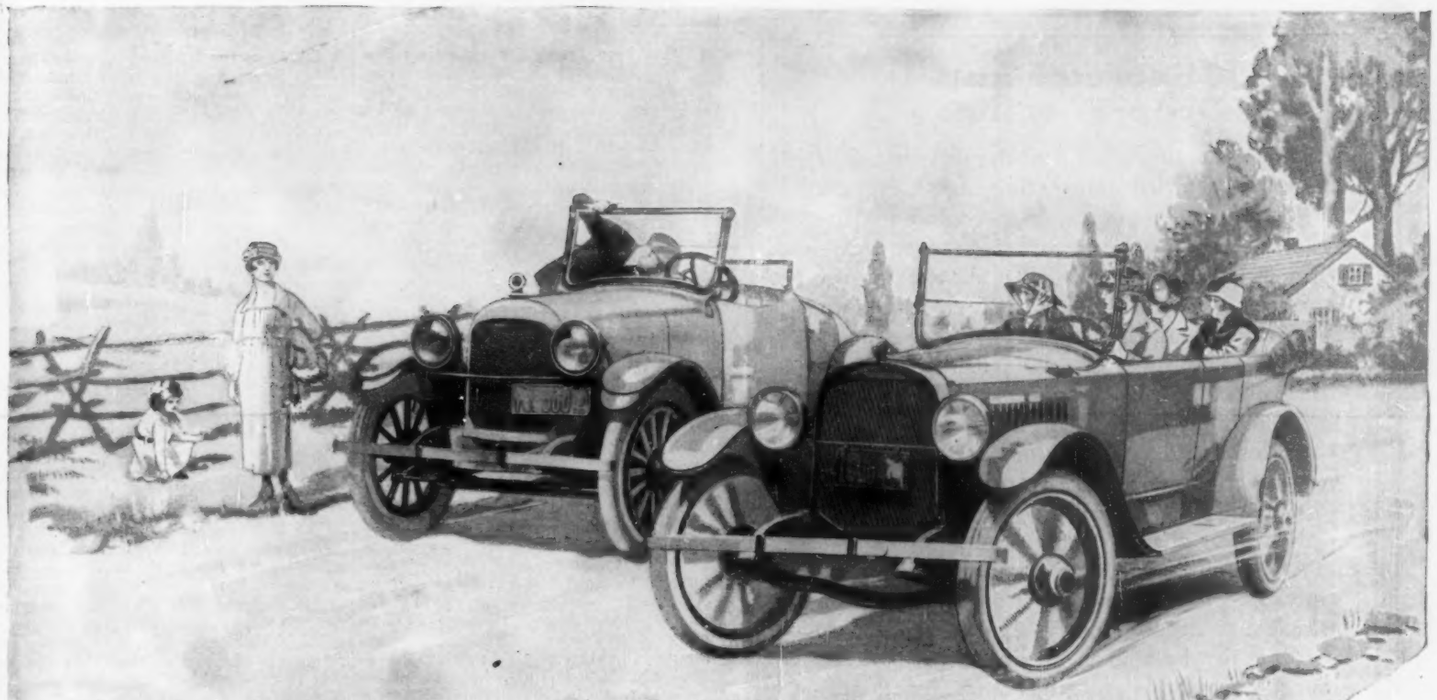
One gallon of oil is used to about 300 gallons of water, the proper mixture being secured by regulating valves attached to a special oil tank. The mixture of oil and water is carried to the nozzle by a ¾-inch rubber hose, the stream being broken up at the nozzle by air supplied through a ½-inch nipple. The air and water pressure should be as nearly equal as possible and approximately 90 pounds per square inch. The temperature of the water should be about 100 to 120 degrees F. as cooler water does not produce as good results. The oil used is a light straw gas oil or petroleum distillate having a paraffine base and ranging in gravity from 32 to 36 degrees. The cleaning can be done inside the round house if desired, but is more conveniently handled at some point on the track by which the engines reach the house. No difficulty is experienced in using the process in severe winter weather, and it has been operated with entire success at zero temperature.

When the process is regularly used, locomotives can be thoroughly cleaned by two men in from 10 to 12 minutes. The cost including labor, material and up-keep of equipment will not exceed 30 to 40 cents per cleaning. The first cleaning requires more time, as it is necessary to remove accumulated dirt and oil. The advantages of the process as compared with hand wiping are: greatly decreased cost due to the saving in labor and wiping waste, a saving in time both in cleaning and repairing and a more complete cleansing of the surface, which makes thorough inspection possible.

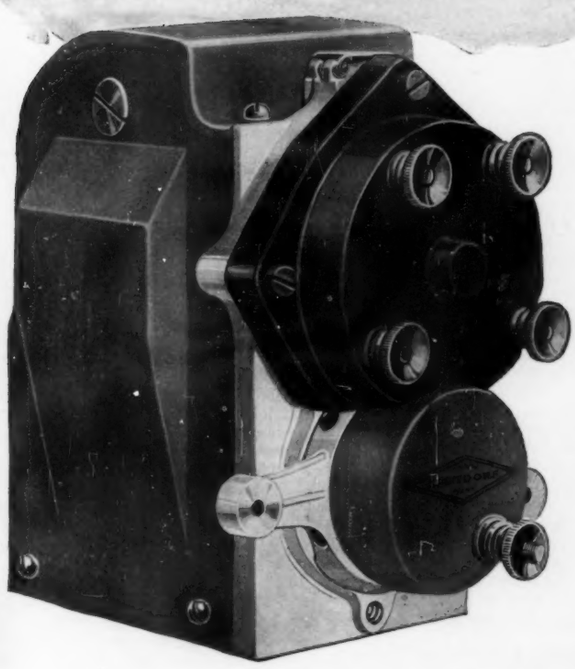
The Percussion Cap

It was some time after the discovery of powder before the first gun was invented, supposedly by a monk named Berthold Schwartz, about 1325. The combination of gun and gunpowder soon became popular but they had some inconveniences attached to their use. After the gun was loaded it was necessary to apply a lighted match to the vent hole to set off the charge. It was difficult to aim and fire with precision. Rain and wind made the use of the gun almost impossible. For five centuries there was comparatively little improvement in firearms. The first great advance was the invention, in 1825, of the percussion cup. This was rendered possible by the discovery of substances which would ignite or explode on being subjected to friction or a blow. Chief among these substances are fulminate of mercury and chlorate of potash. Chlorate was discovered about 1786 by Count Berthollet. Chlorate, like saltpeter, contains a large amount of oxygen which it is ready to give up. It gives up its oxygen much more easily than salpeter, however as, any blow or friction will start trouble if the chlorate is mixed with an inflammable substance. A mixture of sugar and chlorate, or of sulfur and chlorate make violent explosives.

After these chlorate mixtures were discovered it was found that by placing some of the substance in the pan of a gun and allowing it to be struck by a properly constructed hammer, the gun could be fired with more certainty than with the old flint lock. Afterwards fulminate of mercury was discovered. This substance was soon found to be suitable for making percussion cups, and it is today used for this purpose to such an extent that it is one of the most important of explosives, in spite of the fact that it is used only for the purpose of starting the explosion of other substances and never used by itself. It is a grayish poweder, extremely sensitive to shock or friction, and very dangerous to handle. When it is ignited or exploded it always goes off with extreme violence. For this reason it seems to be particularly suited to act in starting the explosion of relatively inert substances such as T. N. T.



Makeshift ignition or dependable ignition?



Is your whole car helpless when your starting and lighting system gives out—when you forget to do one of the many things necessary to keep the overworked starting-lighting-ignition system in order?

Is your engine handicapped by one of those "Jack-of-all-trades" ignition systems that, after it has spent itself to light a half dozen lights and start your husky engine, feebly attempts to fire the cylinders?

Or is it one of those sensitive, high-strung, powerful engines of stamina and endurance that answers your every wish, almost before you have wished?

Is your engine, in short, retarded by a make-shift ignition whose only excuse is that it saves the manufacturer money—or is it helped and invigorated by a self-contained, independent, dependable magneto, that in the end saves *you* money?

Be sure your next car is equipped with a Splitdorf Magneto. It is far above other magnetos in simplicity of construction and dependability as magneto ignition itself is above battery ignition.

SPLITDORF

Electrical Co., Newark, N.J.

Sumter Division, 1466 Michigan Ave. Chicago

TRADE SPLITDORF MARK

Manufacturers of AERO, DIXIE and SUMTER Magnetos, Oscillating Magnetos and Starter Couplings

Character and Drop-Forgings

WHAT connection can there be between Character and Drop-Forgings? Let's see.

In a group of average men there does not appear to be any outstanding difference when everything is running *smoothly*. But, under the strain of a great occasion demanding the utmost strength of body and soul, the man of character assumes the responsibility, carries the load and shows that he stands head and shoulders above his fellows, tho undistinguished from them previously.

So, also, in Drop-Forgings; they may *look* very much alike and serve equally well *until* a great and unusual strain is thrust upon them —then their character stands out.

And William's *Superior* Drop-Forgings embody the character of an organization which has devoted nearly half a century to making the best drop-forgings that can be made, dependable forgings that meet, adequately, any strain, whenever it comes.

J. H. WILLIAMS & CO.
"The Drop-Forging People"

Western Office and Warehouse:
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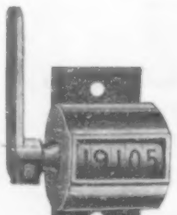
Stabilized Profits

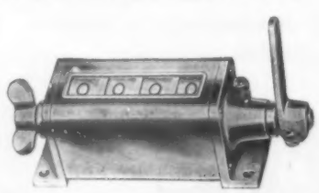
The machine that's "running well" isn't necessarily producing for *all it's worth* to you. It pays you the most when you count the output, find the standard production-rate and *make it the rule* with a

Veeder
COUNTER



The small Rotary Ratchet Counter at left counts the output of machines where a reciprocating movement indicates an operation. When lever is moved through an angle of 40 to 60 degrees, the counter registers one. A complete revolution of the lever registers ten. Though small (illustration full size), this counter is very durable, and adaptable to a wide range of small machines. Price $1.75.

The large Set-Back Revolution Counter at right registers the number of revolutions of a shaft, where these correspond with the operations of your machine. Set back to zero by turning knob, and supplied with from four to ten figure-wheels, as required. Price, with four figures, as shown, $8.50 (List).
Cut less than one-half size.



There's a suitable Veeder Counter for every machine that should have one—and for hand-counting purposes, too. Let us mail you the booklet that shows them.

The Veeder Mfg. Co., 18 Sargeant St. Hartford, Conn.

Hydrogen from Ferrosilicate for Balloons

IT has been known for some time that large quantities of 75 to 85 per cent ferrosilicon were being made in this country and Canada and sent to England for use in producing hydrogen for dirigilbe balloons. In 1918 British official statistics show that 24,992 gross tons of ferrosilicon, ferromanganese and spiegeleisen were imported as against only 13,640 tons in 1917. Before the war the official data show no record of such imports.

The British admiralty about two years ago built the first of a series of stations for dirigible balloons of the non-rigid type. For supplying these dirigibles with hydrogen, the admiralty contracted with a French company which had constructed an efficient type of generator. It was guaranteed to produce 52,975 cubic feet of hydrogen per hour; at the official tests it yielded 13 per cent above this requirement the gas having a lifting power of 0.073 pound per cubic foot. A London engineering paper publishes the following interesting account of the plant and process.

The plant operates the silicol process, which consists in the decomposition of silicon alloys obtained in the electric furnace, such as ferro- or mangano-silicon, or even ferrospiegel, by a concentrated solution of caustic soda (35 per cent to 40 per cent of NaOH). The silicon alloys are made to act on a caustic alkali solution having a high boiling-point, the object being to retain in the solution itself all the heat generated by the reaction in the combination of the silicon with the alkali, thus doing away with all outside heating.

The installation contains a vat provided with a stirring device for preparing the caustic soda solution. The lower part of the vat is fitted with a pipe provided with a valve and ending in a gas generator; the latter is fitted with a planetary stirrer, and has at its top part a receiver containing the silicon alloy. The receiver has a hopper-shaped base in which acts a distributor worked by a crank.

"Soda in lumps, in pieces of cylindrical shape, or in slabs, is put in the vat to the extent of one and a half times or double the weight of soda to that of water; the stirring device is started running and the dissolution of the soda takes place, the heat thereby evolved being sufficient to raise the temperature to about 60 degrees or 80 degrees C. The solution is then led into the gas generator, which it should reach at a temperature sufficient to start the reaction on contact with the silicon alloy. The planetary stirrer causes the silicon alloy powder falling from the hopper-shaped base of the receiver to come into intimate contact with the caustic soda solution, and prevents it from accumulating in the center of the generator. The hydrogen gas, which is evolved at a high temperature, flows into a scrubber-condenser, where it loses the water vapor and is cooled at the same time. The hydrogen gas then flows out through a pipe for utilization.

"The water used for cooling the gas in the scrubber-condenser, which leaves this at a temperature close upon boiling point, is recovered, and is utilized in the vat or in the gas generator as needed.

"The advantages of the silicol process lie in the use of a silicon alloy in which the cost of the unit of silicon is a low one compared with that of the industrially pure silicon hitherto used for the same purpose, this leading to a great reduction in the cost price of the hydrogen gas. In installations where a weak solution of caustic soda is used, a neutral silicate of soda is formed, while when working with a concentrated solution, an acid silicate poorer in soda is obtained; this leads to a saving in caustic soda and allows the obtaining of non-caustic residues which can be utilized for dyeing and bleaching. The water-gage can be suitably connected to the powdered silicon alloy distributor so as to cause the delivery of the alloy powder to vary automatically with the consumption."

Rare Elements As Paint Pigments

By Henry A. Gardner

MANY of the rarer elements that heretofore have had little industrial application, received much consideration during the war-time period. It is probably safe to state that many of them will be used as the basis of preparations destined to become of great importance in the arts. Their possibilities as pigment bases, for instance, has for several years engaged the writer's interest. Among the more obscure or not commonly known metals that he has experimented with are molybdenum, cerium, lanthanum, selenium, thorium, titanium, tungsten, uranium, vanadium, zirconium, beryllium, and radium. Nearly all of the above metals, in the form of their respective insoluble compounds, have a high refractive index and consequently produce, when ground with oil, very opaque mixtures having a hiding power comparable with lead or zinc pigments.

From the standpoint of war-time usage, radium pigments have been of the greatest interest; substantial quantities having been used and with most successful results on the dials of altimeters, air speed meters, and similar aircraft instruments, and on other military paraphernalia used in modern warfare. The radium may be applied as a salt to an active or sympathetic base having real pigment properties, such as zinc sulfide. This activated pigment is mixed with a thin, clear varnish that acts as a binder. Only small amounts of radium salts are required in such paints to produce energetic vibrations that send out active radiations in the form of a soft greenish glow. The light produced is sufficient for the result intended. The radium salts used are manufactured largely from carnotite ore mined in Colorado. These paints have almost entirely replaced the old luminous calcium sulfide paints which, although comparatively low in price, depend upon absorption of energy during the daytime when exposed to sunlight. They are of but short life and not intensely phosphorescent. The only substitute for radium is mesothorium, an element found in monazite sand that is mined in certain of our Southern States. This sand is the product from which thoria is extracted for use as the glow base for incandescent gas mantles; as high as five per cent of thoria being present in some American sands and nine per cent in some of the East Indian varieties. The mesothorium present in the sand is, like radium, capable of sending out active radiations and has been used as the basis of some luminous paints. Its longevity is not as great as that of radium.

Selenium, an element analogous in some of its properties to sulfur, which is obtained during the smelting and refining of copper, has had but little industrial application. The writer has prepared several most interesting pigments from it (the selenites of lead and barium, for instance) which are very white and of fine grain. Their exceptionally high refractive index gives to them intense opacity. Other pigments of a closely related nature may be produced from beryllium, an element found as a silicate or aluminate in several Eastern States. The oxide and similar products of zirconium have a very high degree of whiteness, opacity, and permanence. From titanium, an element which is widely distributed, many most interesting compounds have been produced, and it is highly probable that they will some day be used to a great extent as pigments where great opacity, permanence, and other closely related physical properties are desired.

Among the more common elements from which white pigments may be made are arsenic, antimony, bismuth, and tin. The color compounds of these metals produce black, yellow and orange pigments that have had but little use. When their salts are precipitated as oxides, oxychlorides or other basic salts, white pigments of high opacity are obtained. The toxic nature of some of these products and their high price has limited or prevented their use.

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